A " CRITICAL " STUDY

OF

CHEMICAL EDUCATION MATERIAL
(CHEM. STUDY)

Vis-a-vis

THE POSSIBILITY OF ITS ADAPTABILITY

FOR
HIGHER SECONDARY (FINAL) CLASS,

OF
HIGHER SECONDARY SCHOOLS IN DELHI
UNDER
THE CENTRAL BOARD OF SECONDARY EDUCATION
NEW DELHI

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ABBREVIATIONS USED

Sr. No.	Abbreviation	Explanation
1.	CBSE, New Delhi	Central Board of Secondary Education, New Delhi.
2.	Chem. Study	Chemical Education Material Study
3.	In Chapter T	C = stands for Chapter (of Chem. Study) T = stands for Topic (CBSE Syllabus)

* * *

CHAPTER - 1

CHEMISTRY - AN ELECTIVE SCIENCE

(CENTRAL BOARD OF SECONDARY EDUCATION, NEW DELHI)

VERSUS

CHEMISTRY - AN EXPERIMENTAL SCIENCE

(CHEMICAL EDUCATION MATERIAL STUDY)

GENERAL INTRODUCTION

The Central Board of Secondary Education, New Delhi, envisages different streams consisting of five subjects each for the Higher Secondary (final) Examination. Out of various streams, the 2nd stream or group B is Natural Sciences Group. Here the students choosing science stream have to offer Chemistry as an Elective subject alongwith four other subjects. Chemistry is studied on compulsory bases by students offering Technical Stream (Multipurpose Examination) and as an Optional subject in Group II or B both in the Higher Secondary or Multipurpose examinations. In other Boards of Examinations, elsewhere in India, chemistry forms a part of Agricultural stream too. Again, in Delhi or New Delhi, the school may be a Higher Secondary or a Multipurpose one, but being under the jurisdiction of the said Board as regards the conducting of the Examination and offering Science Stream, the course of study in Chemistry and syllabi is practically the same.

THEORY - CHEMISTRY

The Chemistry syllabi of the Central Board of Secondary Education, New Delhi envisages;

1. Two papers in Chemistry Theory and out of these paper dealing with Inorganic (Non-Metals) and elementary Organic Chemistry and then paper II comprising General and Physical Chemistry and then Inorganic (Metals). Of course, a due stress has been laid on fundamentals and marks for each portion have been divided accordingly.
2. Practical Examination in Chemistry dealing with and covering various topics from simple chemical operations to salt analysis. Also in theory paper, candidates are required to give an evidence in their attempt that they have done various experiments independently and thereby to explain certain theoretical puzzles on the basis of their knowledge of Chemistry practicals.

CHEMISTRY - THEORY

The whole syllabus as laid down earlier has been divided into four groups:-

(i) General and Physical)
(ii) Inorganic (Non-Metals)) PAPER - I
(iii) Inorganic (Metals)
iv) Organic Chemistry (Ele.)) PAPER - II

and all these 4 groups taken together have been subdivided into 35 broad-based topics. Each topic or broadly speaking, each Unit is complete in itself. It covers all the concerned sub-topics duly included in it and as such the syllabus gives

a vivid picture, descriptive of its various aspects. Every topic or unit tends to be 'complete, full, natural, cohesive and comprehensive in itself. The syllabus set in is such that every topic tends to acquire above characteristics.

CHEMISTRY - PRACTICALS

Similarly, in Chemistry practicals, the syllabus is divided into four different units;-
The courses of study over even simple chemical operations and then take the learner to salt analysis. First set of experiments are on simple chemical operations. Second set of exercises deal with a few prominent preparations. Third set includes exercises both of gravemeteric and volumeteric nature. Fourth set of experiments prescribes salt analysis, wherein the given soluble salt (soluble in H_2O/HCl) is to be analysed for one single radical each from the two sections; Acid and Basic sections.

Here again, each set of excercises prescribed gives the beginner a sufficient ground to grow in and learn chemistry. Each set involves various side operations and these operations are interconnected and interwoven. All these exercises are based upon one or the other chemical operations and thus the student learns a lot out of it.

The effort has been made byy the framers of the syllabus to give it a continuous and interlinked shape. The topics have been properly graded, keeping in view students mental age, his previous knowledge and load of other subjects and the need of standard required for entry into a University

or an institution of a Professional learning say a Medical College or a college of Engineering and Technology. This all is properly explained by the combination of theory and practicals together.

Books Provided:

As usual the Central Board of Secondary Education, New Delhi, prescribes two boks for all students;-

The first book is a Text Book which covers all the topic in a certain set manner. The whole text describes those topics in the form of chapters and various chapters taken together constitute a Unit and various units cover the whole syllabii. The Text Book is meant for students and Teachers alike. It is a source book for the Teacher, it is a guide book for him. For students, the Text book is indispensable.

The second book prescribed is on 'Practical Excercises' in Chemistry. It describes all the experiments in lucid and step wise details.

There is no book with the name Teachers' Guide prescribed by the Central Board of Secondary Education, New Dehi.

CHEMICAL EDUCATION MATERIAL STUDY: CHEM STUDY PROGRAMME

GENERAL INTRODUCTION

Chemical Education Material Study Group was set up up under a grant from the National Science Foundations, U.S.A. and it prepared a set of books on Chemistry - An Experimental Science, collectively called 'CHEM STUDY BOOKS.' The Chem.

tudy Group was set up under the Chairmanship of Prof. G.T. Seaborg, Noble-Laurate, University of California, Barkley, California and Prof. J.A. Campbell, Harvey Mudd College, Claremont, California, was the Director of the group. There were as many as twenty contributors towards the material of this project. Again, these experts included University Professors, Teacher Educators, Research Chemists and Science Teachers. The novelty of the whole idea lay in that the University Professors came to teach school chemistry. Noble-Laurates, so far the monopoly of Universities, were now available in schools and University Research Scientists realised the importance of school science. Teachers-educators and Professors from College of Education came down to school level.

The Science Teacher, too, felt his importance and he was made the pivot of the whole of the new programme. He occupied a prominent position alongwith University Professors, Research Scientists and Teacher-Educators as regards various Committees on Science curricula, Committee on Teacher's Guide that on Resource-Book or Lab. Manual and so on.

BOOKS IN CHEM STUDY PROGRAMME

Chem. Study Committee prepared three important books on the programme. These books are;

(i) CHEMISTRY - An Experimental Science; Text Book or Resource Book

(ii) CHEMISTRY - An Experimental Science; Lab. Manual

(iii) CHEMISTRY - An Experimental Science - Teacher's Guide.

These books are described here.

(i) CHEMISTRY - AN EXPERIMENTAL SCIENCE TEXT BOOK

It is a Resource Book for use by students. Teachers also use it with ease and profit. But it is mainly for students use. Chemistry-an Experimental Science; the Text book presents Chemistry as it is to-day. It does so with emphasis upon the most enjoyable part of chemistry; an experimentation.

The book is divided into chapters. There are 25 chapters and four explanatory appendices and it has got 460 pages in all (foolscap papers). It covers one year course in a selected American School. It does not classify topics into organic or inorganic sections. It presents chemistry as one unified, as a whole. Even physical or General chemistry is not separately marked. Subject grows after subject, chapters come after one another. It starts with chemistry; as an 'experimental science'. It describe 'Atomic Theory' as 'Scientific Model' - the two topics which given an insight into the subject. The various chapters taken here are arranged haphazardly and the various topics discussed overlap each other. There being no clear distinction or demarcation as to why and how these topics have been graded or placed in the given order.

(ii) CHEMISTRY - AN EXPERIMENTAL SCIENCE: LABORATORY MANUAL

Chemistry - An Experimental science, its Laboratory Manual is a book on practical excercises in Chemistry. The whole book is divided into five parts. Each part is sub-divided into different sets of experiments. There are 46 experiments in all to be covered during one year course of

Chem. Study Programme.

There is a list of additional experiments attached in the appendix.

To start with, Lab. Manual introduces the beginner to:-

1. Laboratory Instructions.
2. Laboratory Report
3. Laboratory Apparatus.

Laboratory Manual has got following parts:-

(1) Part I: Observation, Interpretations, Precision of Measurement (1-5 experiments).

(2) Part II: An Introduction to Chemistry, Mole concept, Avogadro's Hypothesis and Gases solutions (6 experiments, (16-11).

(3) Part III: Investigations of Chemical Reactions illustrating important principles (12 experiments, 12-23)

(4) Part IV: Theoretical concepts. Atomic Structure, Chemical Bonds, Structure and properties (4 experiments-, (24-27).

(5) Part V: Application of Chemical Principles to Descriptive Chemistry (14 experiments (28-41)

Optional experiments; 5 (4a, 8a, 8b, 14a, and 29a) and the appendix with other details.

In these experiments working details are provided. Background and introductory discussion is given in the beginning of each chapter i.e. before the experiment is described. 'Questions and Problems' have been asked at the end of each experiment.

(iii) CHEMISTRY - AN EXPERIMENTAL SCIENCE - A TEACHER'S GUIDE

The third important book on Chem. Study Programm, is a 'Teacher's Guide'. As the name suggests, it is guide for the teacher, who uses or teaches Chemistry from Chem. Study Material. It is guide for the Teacher to Chemistry, an experimentalscience, a Resource Book for students. The Teacher's Guide gives some hints and introductory remarks on Chem. Study Programme, it tells about organisation of Teacher's guide and it describes and serves as introductory guide to laboratory work. After that, it discusses all the 25 chapters in the original Text Book referred to as No.I above. The book is a complete guide for the Teacher. It describes each chapter with (i) Background Discussion (ii) Intent and purposes (iii) Outline of the Chapter (iv) New concepts, if any (vi) Developments etc. of the subject matter discussed in the text book.

After above discussions, it describes the inter-related (to that chapter) experiments from the Lab. Manual. Here again it gives (i) Purpose of the Experiment (ii) Pre-Lab. Discussion (iii) Actual details (iv) Lab. Hints (v) Precautions etc. (vi) Post-Lab. Discussion. Having covered the related experiments, it gives or suggests Supplementary Material for extra reading in the form of (i) Additional Books with the names of authors and publishers (ii) Chem. Study films.

Last Part of this is 'Answers' to questions and problems in the Text or Lab. Manual and then it gives 'Suggested Quiz' and so on. Then it takes up next chapter. Thus in

brief, the Teachers Guide is a complete key to both the Text Material and the Lab. Manual. More than that, it suggests new 'Quiz' or 'Set of Quiz', it gives background discussion for each chapter. It then details Pre-Lab. and Post-Lab. discussions. It makes the whole set an interesting piece of Chemistry for a Teacher.

SUBJECT OF CONTRASTS, COMPARISON AND COMMON TO CBSE AND CHEM. STUDY PROGRAMMES

Now the close study of the two syllabii shows that there are some subjects which are common to both the programmes, there are some subjects which are available in the CBSE Scheme, New Delhi, but not available in Chem. Study and similarly there are some topics which are found in Chem. Study material. but not in our CBSE Schem, New Delhi. We take up such subjects one after the other in the following pages:-

Subject common to both the CBSE and the CHEM. Study Programme

Now the first thing we are supposed to do is to opt out the topics or subjects which are commong to both the CBSE and the Chem. Study Programmes;

It is a very tedious job to find out the topics which are available in both of the projects. It being so, ours is a different society, different from that of Americans, where Chem. Study Programme is being followed. The needs of two societies are different, their requirements are wide apart, the two standards are alike, we expect something from young learners, they expect something different from their children. Hence it is obvious that two syllabii cannot have

much in common, as regards outlines of the same. While having gone through both the programmes, it has been notably observed that the subject matter, its length, way of presentation, the arrangement of subjects in the text i.e. their sequence, the topics i.e. excercises for practicals, their relation with corresponding subject in the Text all these factors vary apart from one programme to another and so on. In fact there is nothing in common, strictly speaking, between the two programmes except the same heading for a particular chapter/topic. This is so because of reasons of cultural differences and pedagogical standards being different in the two societies. However the common topics which bear the common names with little bit of deviation this way or that way are listed below;-

2. The Gas Phase : Chapter 4 (Chem. Study)
Three states of Matter; Gases (Liquids and solids
CBSE, T.8)

3. Liquids and Solids; Condensed Phases of Matter
(C-5) Chem. Study
Three states of Matter: (Gases) Liquids and Solids)
CBSE, T.8)

1. Chemistry : An Experimental Science (C-I) Chem. Study - First Experiment in Lab. Manual Scientific observations and Description (Chem. Study)

Structure and Nature of flame. Luminosity of the flame: T-16 (CBSE)

4. Aqueous Acids and Basis; C-11 (Chem. Study)
Acids, Bases and Salts; Gen. Methods of their proportions - General chracteristics, classification and nomenclature (CBSE T.11)

5. Oxidation-Reduction Reactions (C.12) (Chem. Study)
H2 and O2 ; H2O (Chemistry/, hydroxides;
OXIDATION AND REDUCTION O3, H2O (T.19; CBSE)

6. Chemical Calculations ; C-13 (Chem. Study).
Chemical equation and its significance.
Chemical Calculations (CBSE, T.7)

7. Chemistry of Carbon Compounds; Chapter-18 (Chem. Study)
Distinction between Organic and Inorganic Compounds
Elementary analyses of Organic compounds.
Determinatin of emperical and molecular formulae
from given percentage composition (T.29) (CBSE)
Hydrocarbns. Nomenclature (T.30 30-A, CBSE)

8. Halogens; (C.19, Chem. Study)
Chlorine Hydrochloric acid, chlrides, Bleaching
powder, NaOCl; B (their relationship with Cl_2 (T.22,
(CBSE)

9. Third Row of Periodic Table (C.20 (Chem. Study)

10. Allotropy, H2S, SO_2, $H_2 - SO_3$, $\overset{=}{SO}$3, H2-SO4 and $\overset{=}{SO}_4$
(CBSE, T.23)
P, PH3, P2O5, H3-PO4 and $\overset{\equiv}{PO}_4$, PCl3 and PCl5 (CBSE,T. 2
Si, its actin on bases NO_3 SiO3, Glass, Borax,
Boric acid CBSE, T.25; Cu.....Zn, (T.26, CBSE)

11. Fourth Row of Translation Elements (C.22, Chem.Study)
Cu....... Fe. (CBSE, T.26)

Note

(1) While trying to find out these similarities, it has been observed above that there is some common feature between

the similarly bracketted topics. (ii) While taking the case of IX, X and XI cases referred to above, it is to be noted that in case of Chem. Study Material, the periodic law and the arrangement of those elements there in and then giving the chapters the corresponding headings shows the pre-dominance of the Periodic Table as given by Mendeleef, while similar to that we have topics in the CBSE Scheme where there is no mention of Periodic law though periodic classification is included in the syllabus and yet corresponding elements listed in above are scattered and studied as Non-Metals and Metals etc. instead of being in the form of groups on periods.

Topics exclusively in the syllabus of CBSE, New Delhi but not included in Chem. Study Programme

Having discussed topics or subjects common to both the programmes, we now make a mention of those subjects which are exclusively included in the syllabus of Cetral Board of Secondary Education, New Delhi but not found in the Chem. Study Programme. These topics are:-

1. General and Physical

1. Chemical change and its chracteristics; distinction from physical change; conditions that influence chemical affinity; different kinds of chemical action. Elements, compounds and mechanical mixtures.

2. The atmospher: The nature and action of air; air a mixture, the part it plays in chemical changes, its relation to plants and animals.

3. Water: Hard and soft water; water as solution

saturated and super-saturated, solubility, decantation, filtration, evaporation, distillation and crystallisation.

5. Methods for the purification of substances and separation of Mixtures. Sublimation.

6. Dalton's atmic theory and laws of chemical combination. Law of (i) onservation of Mass (ii) Definite Proportions (iii) Multiple Proportion (iv) Equilant Proportion and (v) Gaseous volumes.

6. Atoms, molecules, chemical symbols, valency and formulae, empirical, molecular and simple structural formulae.

7. Chemical Equation and its significance

8. The general properties of gases, statement and application of Boyle's law. Charles' law. Dalton's law of partial pressures. Gaseous dissociation. Liquid Gases. Graham's law of Gaseous diffusion.

9. Molecular weight: Definition, application of Avogadro's hypothesis in the determination of molecular weights of volatile substances by Victor Meyer's method.

10. Definition and the simple methods for the determination of equivalent and atomic weights.

11. Acids, Bases and Salts: General methods for their preparation, their general chracteristics, classification and nomenclature.

12. *Relation between molecular weight, equivalent weight, basicity* and *acidity*. Determination of equivalent weights of acids and bases by volumetric methods.

13. *Electrolysis*: Faraday's Law and application, explanation of the terms acids, bases and salts.

14. *Ionic theory*: Its application to the explanation of the terms acids, bases, salts; neutralisation, precipitation (solubility product). Electrolysis, Hydrolysis.

15. *The structure and nature of the flame.* Luminosity of the flames.

16. *Catalytic agents*, their mode of behaviour, mechanism and application.

II — *INORGANIC* (NON-METALS)

17. *Characteristics of metals and non-metals.* The periodic classification of elements.

18. *Non-metals and their important compounds* (including *Industrial preparation* of those given in italics).

19. *Hydrogen*, *Oxygen*; Water, Oxides and hydroxides; Ozone, hydrogen peroxide.

20. Nitrogen-oxides, *ammonia*, *Nitric Acid* and Nitrates, Nitrogen cycle in nature. Fixation of atmospheric Nitrogen and Fertilisers.

21. *Carbon dioxide* and carbonates. Carbon monoxide.

The carbon cycle in nature.

22. HCl. Metallic chlorides, $CaOCl_2$, NaOCl.

23. Allotropy, hydrogen sulphide, sulphur dioxide, sulphur dioxide, sulphurous acid and sulphites. Sulphuric acid and sulphates.

24. Phosphine, phosphorous pentoxide, phosphoric acids and their sodium salts. The chlorides of phosphorus.

25. Action of silica upon bases, sodium silicate, glass borax, and boric acid.

III - INORGANIC METALS

26. Ag, Hg, Pb

27. Alloys and their importance, qualitative composition and uses of the following:-

Bronze, Brass, German Silver, Bell-metal,
Type-metal, Duralumin and Magnalium.

28. Study of the following compounds:-

Sodium hydroxide, peroxide, bicarbonate, chloride, sulphate, thiosulphate, nitrate, nitrite and phosphate.

Potassium chloride, bromide, iodide, carbonate, nitrate and nitrite.

Silver nitrate, chloride, (photography).

Calcium carbonate, oxide and hydroxide, plaster of paris, carbide, chloride and super-phosphate.

Zinc oxide, carbonate and sulphide

Mercurous chloride, mercuric oxide and chloride.

Aluminium hydroxide. Alums, oxides of lead, white lead, Ferrous sulphate, ferric alum. Rusting of Iron.

IV-ELEMENTARY ORGANIC COMPOUNDS

29. Distinction between organic and inorganic compounds

30. Elementary analysis of organic compounds, determination of empirical and molecular formulae from given percentage composition.

31. Nomenclature. Methane and Ethane, Homologous series, Isomerism. Petroleum.

32. Unsaturated hydrocarbons - Ethylene, acetylene-characteristic behaviour of unsaturated molecules.

33. Preparation and properties of Methyl alcohol, ethyl alcohol, formaldehyde, and acetic acid.

TOPICS EXCLUSIVELY IN CHEM STUDY PROGRAMME

Now we take up those topics which are exclusively available in Chemistry - An Experimental Science Chem. Study Programme and not found in the syllabus of C.B.S.E., New Delhi. The chapter wise topics are:-

Chapters:

1. Chemistry - An Experimental Science
2. A Scientific Model - The Atomic Theory

3. Chemical Reactions.
4. Structure of the Atom and the Periodic Table
5. Energy Effects in Chemical Reactions
6. The Rates of Chemical Reactions
7. Equilibrium in Chemical Reactions
8. Solubility Equilibria
9. Why we believe in Atoms
10. Electrons and the Periodic Table
11. Molecules in the Gas Phase.
12. The Bonding in Solids and Liquids
13. Some Sixth-and Seventh-Row Elements.
14. Some Aspects of Biochemistry: An Application of Chemistry.
15. The Chemistry of Earth, the Planets, and the Stars.

CHAPTER - 2

CHEMISTRY - THE CBSE SCHEME . THE CHEM STUDY PROGRAMME

Philosophy and objectives of the two Projects:

The two courses of studies in chemistry, as expected have a different approach, philosophy and objectives of teaching the subject. This difference in philosophy and objectives is expected and depicts the cultural, national, environmental aspects of the two societies. The broad features of difference are depicted here;

Philosophy and objectives; Teaching of Chemistry in the CBSE Scheme, New Delhi

A - Philosophy behind the CBSE Scheme, New Delhi

(i) The Central Board of Secondary Education, New Delhi, envisages chemistry to the taught as an elective subject in Class XI or 2nd year of the Higher Secondary stage and it lays stress on bth theoretical and practical aspects of this branch of science.

(ii) Chemistry is to be studied as a part of the Natural Sciences Stream (Group B) or that of Technical Group or the group leading to studies in Agriculture and Veterinary Sciences or that to study of Medicines.

Note; This is the philosophy of the subject being taught as a part of science etc. stream. But this approach has been envisaged to be changed as recommended in the Education Commission's Report (1964-66) and as such chemistry can be taken alongwith subjects of Humanities group etc. This shift has been since 1966, when

the Kothari Comission's report was published. But even then, the same is not depicted in the syllabus of CBSE Scheme New Delhi or else where in or study system in various parts of the country. Chemistry continues to be a subject in the science stream and cannot be taken alongwith humanities.

(iii) The philosophy underlying in formulating the syllabus of the CBSE Scheme New Delhi or else where in the country has been that usual formulation has been done by the University Experts, Professors and Research Scientists, and School Teachers as such had no hand in the formulation of the syllabii etc. The class room teacher was neglected. The Board of syllabus in chemistry or that of curriculum forming in the subject has been more or less, broadly constituted of University Professors and there has been no association of class room teachers from schools in the matter. Even Teacher Educators have been neglected for the purpose.

Note: Here again we make the following observation:-

In the traditional approach, the syllabus formulation the curriculum construction and inclusion of subject matter and thereby selecting the topics and sub-topics has been decide by the University men alone. But, of late the position is different. Now the association of school teachers is a must on any Board or committee formulating the syllabus. Now no such committee has even been constituted without the inclusion of a school teacher. Rather now it is a school expert whose presence and active participations is a must in the team forming or deciding the syllabus. This is a very recent trend

in school education in general and in Science Education in particular. Again, it is worth while to make a mention of the fact ~~[illegible] the [illegible]~~ that the recent trend of associating the school authorities with school science has its origin in the Department of Science Education, National Institute of Education (N.C.E.R.& T), New Delhi. The Department of Science Education had given a lead in this direction. Ever since the Department of Science Education took up the work on National Project on improving school science, it set up study-groups in various science subjects and these study groups are headed by University/College Professors and others associated with teaching of science at the University or School Teachers or Teachers Training College level. Of course this team or group makes use of the services of experienced science-teachers.

B - Objectives

There are no clear cut objectives of the present course of chemistry as prescribed in the CBSE Scheme, New Delhi and as such no objectives have been enlisted there. But the very fact that the syllabii in chemistry as recommended by the CBSE, New Delhi ise serving a multiple variety of purposes, the following can be enlisted as the main objectives:-

(i) The main object of this course is to provide a systematic and practical idea of chemistry - the science of substances and changes they undergo.

(ii) The present syllabus with a large variety of topics, provides an understanding of the

chemical phenomena based upon systematic development of the subject matter.

(iii) The practical part of it provides to develop at a more sophisticated level both manipulating and experimental skill.

(iv) The syllabus and content as a whole starts from physico-chemical concepts based upon electronic structure of matter and the periodic classification of elements and leads to as detailed topic as extraction of metals or their metallurgies and then to preparation of compounds, their properties and uses.

(v) The content of the syllabus consists of topics from various branches of chemistry and also introduces the beginner to learn fundamental facts of organic chemistry too. The course - content, thus, introduces the Higher Secondary student to various branches of chemistry - Inorganic, physical and organic. This course content does, in addition to introducing the learner to two aspects of chemistry; theoretical and practical, as explained earlier.

(vi) Chemistry being a science of material substances and the changes they undergo, the present content provides for a large varieties of substances to be studied, to be handled and to be experimented upon.

(vii) To explain the above point further, we see that the syllabus provides a large variety of demonstrations by the teacher, laboratory excercises and then independent experiments to be done by the students themselves.

(viii) The content-course introduces the students passing school final to learn the subject further at the college or the university stage and thus it provides a good background for learning chemistry at Degree or Post-graduate levels.

(ix) The course-content also provides to be a qualifying one for joining allied professions e.g. engineering, technology, medicines, agriculture or veterinary sciences and so on. It is after this stage that diversification in different professions is decided and it provides the sound basis for that.

Philosphy and objectives: Chem. Study Programme

The philosphy and objectives of the Chem. Study Programme as it developed in the States is as follows:-

INTRODUCTION:

Man inherits his culture. He inherits the evolving culture which his forebearers willed to him. Generally, cultural changes take place slowly. This complex culture has

taken its form from both conscious and unconscious efforts of people.

Most prominents among the conscious efforts of people to provide a better society, in which future generations may live, and influence our rate of cultural change.

A traditional high rate of change seems to be accelerating in industry. In the chemical industry alone we see automation in chemical production, internationalization of chemical industry, diversification into chemical industry by chemical companies, establishment of new process industries, mergers and intergrations both in direction of consumer goods and raw materials as just some of the factors which promise to keep the chemical industry in a state of flux.

These new industrial directions have suggested the need for new fields of science that cross disciplinary lines. Some of these new fields are; Chemical physics, Chemical biology, Biomedical engineering, Biophysics, Asterophysics.

Educators have long been concerned with curriculum development and methods of teaching, but now with this high rate of technological change political and economic concerns have intensified their efforts in this direction. Government and industry with vested interests have been catapulated into the problems of the educator.

Industry and government along with professional societies are now cooperating with educators in studying the

problems of how students may better be prepared to live and effectively contribute to an ever changing world.

Much of the direction is coming from professional societies since they are made up of people from both industry and education. The American Chemical Society is an example of one of these forces today which is giving direction to the study of educational problems.

Members of the society have had mounting concern over the traditional chemistry course taught in high school. It was felt that the historical and descriptive approach still being used no longer provides the student with desirable competence in chemistry.

In conjunction with the National Science Foundation and certain Universities, the American Chemical Society set about to study the problems.

Philosophy and Objectives - Chem. Study Programme

A - Philosophy

(1) The most commonly reoccurring and seemingly basic idea of the CHEM Study is that a chemistry course must be based on an experimental approach. In order to emphasize this the text in the CHEM Study series is titled "Chemistry - An Experimental Science" first day the student comes to class, he lights a candle and is asked to observe what he sees.

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(2) A second basic point of difference is the shift in emphasis from the teacher to the student, the teacher no longer lectures in the traditional sense but guides. The student explores on his own to a greater extent, he observes, records, reflects and to a large measure is his own best teacher.

B - Objectives

(1) To develope new teaching materials for the high school chemistry course, including a textbook, laboratory experiments, films, and supplementary reading materials.

(2) To diminish the current separation between scientists and teachers in the undertaking of science.

(3) To stimulate and prepare those high school students whose purpose is to continue the study of chemistry courses that are geared to keep pace with advancing scientific frontiers, and thereby improve their teaching methods.

(4) To further in those students who will not continue the study of chemistry in high school an understanding of the importance of science in current and future human activities.

(5) To originate a high school chemistry course strongly based on experiments and to have the text thoroughly dependent upon and intergrated into the laboratory experiments with the supplementaluse of integrated films, where they may be helpful.'

(6) To make the course applicable to the average

student who takes high school chemistry rather than to the gifted or upper part of the typical high school class.

(7) To encourage teachers to improve their teaching methods by studying chemistry courses which are geared to keep pace with advancing scientific frontiers.

The student is confronted with basic concepts early in the course, these concepts reappear during the course and become part of a series of learning cycles. The student does not learn materials in individual separate packets but in related integrated whole. Useful ideas and generalizations results from study in depth and are rarely the product of a few assignments.

CHEM Study and especially the laboratory, the laboratory part is sensible and psychologically sound as a way of teaching.

CHEM study chemistry contains the following ingredients:-

a. A discovery approach is made.

b. A search for regularities is made.

c. The use of models to explain regularities is made.

d. Problem solving using laboratory data is very basic in this approach.

e. There is de-emphasis on descriptive material.

f. Real experiments are used to intrduce concepts. Dry labing canot occur.

g. Logical and sequential learning cycles are established.

h. It is exciting and fun to teach CHEM's chemistry.

CHAPTER - 3

COMPARISON OF THE GENERAL FEATURES OF THE COURSES OF STUDIES IN CHEMISTRY BOTH IN THE CBSE SCHEME AND THE CHEM. STUDY PROGRAMME

Aims and Objectives;

The main aim and objectives of the present dissertation is to bring out the common points and those of difference in the courses of studies in chemistry as envisaged in the outlines of the syllabii prescribed by the Central Board of Secondary Education, New Delhi and that in the Chemical Education Material Study Programme, U.S.A.

The study contained in this dissertation is based upon both on intensive studies of the Texts prescribed for the purpose and allied materials available e.g. Teacher's guide and Laboratory Manual etc. as they are available in the two systems and on the study of the outlines of the syllabii etc. in the two Projects.

Comparison and Contrasts;

There are various points of similarities, which are common to both the systems as envisaged in the CBSE Scheme and the Chem. Study Programme;-

(i) XI-Form Course; The syllabus under discussion as prescribed by the Central Board of Secondary Education is meant for final year of the Higher Secondary Examination of the Secondary Board, New Delhi. It is a course of studies for XI class, to be offered by students taking

science as their pursuit in life. It is a preparation for taking advanced studies at the college or the university level or for that reason it serves as an entrance course for entry into certain science based professions e.g. studies leading to Medicine, Engineering, Veterinary Science or Agriculture. Hence syllabus in Chemistry is a multipurpose one and serves the Indian conditions accordingly.

The courses of studies as envisaged in the Chemical Education Material Study Programme is meant for XI-Form at the school stage. In U.S.A., they have 12 years school programme and the Chem. Study Course is meant for 11th Form for an American School.

(ii) Course of Theory & Practicals: Both the courses lay stress on both the theory and the practical aspects of chemistry. In the CBSE Scheme, we have a number of topics for being discussed and lectured in theory classes or during lecture periods and similarly, we have again a number of practicals to be performed during the periods meant for Practical work in a laboratory situation. In other words, we have six periods a week, each period of 40-45 minutes duration and one period a day for Chemistry theory and then 4 periods of similar duration, 2 consecutive periods a day on two days a week for Chemistry practicals.

During theory periods, the main stress is on theoretical aspect of the subject matter discussed topic-wise.

The method usually followed is the Lecture-method and then followed by mutual discussions and putting up of questions by students and their reply coming from the Teacher or from fellow-students based on mutual discussion. Very little attention is paid to practical aspect of chemistry during discussion of theory. While in practical-work, the method followed varies from experiment to experiment. The usual method is Lecture-method followed by individual practical work by students or by Lecture-cum-Demonstration method again followed by individual practical work. Also, it is so arranged that each student carries on practical work individually but in some cases due to lack of apparatus or a large group of students in practical class or due to experimental necessity, two students may work together. After the practical work is over students may bring in their personal difficulties to the Teacher, which is discussed either with the concerned student or with the group as a whole.

Likewise, in Chem. Study Programme, we have a set number of topics both in the Text meant for students and the Laboratory Manual - a book on Practical work, also meant for students. In the Chem. Study Programme, as it is being taught in American Schools and as envisaged in its philosphy and objectives, Chemistry being an Experimental Science, the approach adopted is that of enquiry and investigation and is usually done by individual experimentation, by lecture-cum-demonstration method, followed by periodical assignments and

so on.

While in practicals the approach by the Teacher in the laboratory is more or less the same as we have in our Indian schools. Of course, it is a Lecture-cum-demonstration method and is followed by individual experimentation by students. Here various steps of discussion are:

i) Pre-Laboratory Discussion;
ii) Actual Experimentation;
iii) Post-Laboratory Discussion

Thus essence of discussion is the same both in the CBSE scheme and the Chem. Study Programme. In both the systems, students keep a record of their practical work done in the laboratory.

(iii) A Composite Course; In both the CBSE and the Chem. Study Programmes, a due stress is being laid on all aspects of chemistry; organic, inorganic and physical. There is no sharp division of courses into separate branches in either of the two systems. Mostly it is an inorganic aspect of the same, which is being duly stressed and it includes physico-chemical processes involved. Alongwith that, a little organic chemistry has also been introduced as 'chemistry of carbon and its compounds'.

Points of difference between the two Systems:

Now we pass on to the points of difference between the syllabii and courses of studies in chemistry both

in the Central Board of Secondary Education, New Delhi and Chem. Study Programme (U.S.A.). The points are:

(1) The CBSE chemistry course for All and the Chem. Study Programme for selected and gifted pupils

Chemistry Course as prescribed by the Central Board of Secondary Education, New Delhi is a course for all students. Every student offering Science or Technical stream may study chemistry and the same courses of study in chemistry is meant for all whether a student is average, below or above the average in his mental abilities. The CBSE Scheme does not arrange separate course in chemistry for amongst the science students. It does not discriminate between students on the basis of their mental capabilities.

Note: However, it may be proper to put a note here that while giving admission to students in science streams, a due care is given to their achievement in previous examinations and at the same time, admission is strictly restricted to students of low-achievements and it is made on merit alone. Thus students admitted in science streams are at least of average and above average abilities.

On the other hand, Chem. Study is a programme in chemistry meant for selected and gifted children. All the schools have not adopted Chem. Study Programme for their XI-Form. All students in schools in the States do not have Chem. Study Programme opted as their courses of studies in Chemistry.

In Delhi or New Delhi, all schools which are within the jurisdiction of examinations conducted by the CBSE, New Delhi, have to adopt the prescribed syllabus and all of them have uniform courses of study. Equal number of periods both for theory and practical work are prescribed throughout all schools in the Union Territory. On the other hand, in case of Chem. Study only those schools which are having high standard of education and a lot of reputation etc. have adopted Chem. Study programme. Such schools make admissions on the basis of entrance examination and hence only seleted few have the privilege of going through this course of studies.

Moreover, Chem. Study is still in an experimental stage and not prevalent in all schools. In States, schools are at liberty to adopt or not to adopt any programme of studies and as such there is no Central or Federal directive on American schools to adopt a particular course of studies it suits American conditions. While in India or for that reason CBSE Course followed by all in Delhi and New Delhi, things are highly centralised and so are the courses of studies in chemistry. Hence whatever course of study is prescribed by the CBSE, New Delhi, has to be followed by all schools and by all students in these schools. Ours is a rigid system or centralised system and while that of Chem. Study is an experimental and a decentralised one.

(2) Eminent scientists involved in the Chem. Study Programme and not very much so in the CBSE Scheme

Since long, it has been our tradition, that

the courses of studies and curricula construction did not involve eminent university Professors and Research Scientists, but only Departmental Heads i.e. D.P.Is. etc. alongwith other educationists have been constituting such committees for the purpose. Previously, the school teacher had no say as regards the construction and finalisation of the curriculum. Of recent times, the practice is slightly changed and now the curriculum construction involves University Professors, eminent scientists, Research Scientists and even class teachers (from schools). This is true of CBSE to some extent. But the Chem. Study is a course whereby in the construction of which experts as highly placed as Prof. Glenn T. Seaborg (Noble Laurate) and Prof. J. Arthur Cambell were involved as the Chairman and Director respectively of the Programme. Not only this, the curriculum committee of Chem. Study Programme involves about two dozen experts comprising of school Teachers and Teacher-Educators (College Professors) besides these University Professors. All the experts connected with the Chem. Study Programme are internationally reputed Teachers in the field of chemistry and internationally famed scientists. This is the beauty of the Chem. Study that school teacher, who is actually involved in the class room teaching is a member of the curriculum construction committee on the Chem. Study Programme. It adds to its strength. Not only this, before such like programmes came out, Noble Laurates and Ph.Ds. or D.Scs. were the monopoly of the University Departments of studies etc. etc., but the coming of Chem. Study

changed the whole picture and University Professors and Noble-Laurates so far monoply of the University Faculties, came down to teach school chemistry, school physics or school science even at the elementary schools level. This has not happened in India or for that reasons in New Delhi for obvious reasons prevailing in our Indian conditions.

(3) The CBSE approach is traditional and the Chem. Study is investigatory and enquiry-based

The teaching of Science or for that reason that of chemistry in the CBSE Scheme is traditional. Here we always use 'chalk & talk' method. Teacher speaks or lectures, he imparts facts and factual knowledge is the theme of our teaching in India. Here students are passive listners and they keep on listening and some times taking notes, while the teacher is talking or giving a lecture. This approach of teaching Chemistry is traditional and not suited to teach subjects like chemistry or other science subjects. But it is being followed in schools in Delhi and outside Delhi too.

On the other hand, Chem. Study programme being of recent origin is an improvement over the traditional mode of teaching Chemistry, the Chem. Study approach is based upon enquiry and investigation. Its set up is such that it proceeds on enquiry and investigatory approach. Here the method followed is a scientific method. Student does things as an original research worker. Here imparting of knowledge is not in the forms of facts being narrated, but it proceeds on the

assumption that students read themselves, discuss things amongst themselves and then finally discuss it with their teacher. As regards practicals, here again experiments have been duly graded in set sequence depending upon the order in which topics have been dealt with in the 'Text Book' meant for students.

There is a direct correlation between the topics detailed in the Text and those incorporated in the Lab. manual for the purpose of being performed in the laboratory.

The Teacher's role is that of guide and one who knows the subject well. He has to answer every question put by students or for that reason every doubt raised by students is tackled by the teacher. His is an important role. He is pivot around whom teaching of chemistry - 'an experimental science', depends. Here in Chem. Study programme; Teacher has to be well informed and well conversant with the subject.

(4) Number of Books. On the Two Systems varies. In the CBSE Scheme, New Delhi generally two books have been prescribed. The two books are;

(i) Text book covering various topics as laid down in the syllabus. It discusses the topics in details and gives a vivid treatment of the subject matter arranged in certain order.

(ii) Book on Practical chemistry. It contains all details of various experiments prescribed in the syllabus. Here experiments are arranged in certain order, related to some extent to the sequence of topics in the Text-book.

Here both these books are meant mainly for students, but Teachers also use them for reference. It is a guide for teachers as to what is to be taught and the sequence in which it is to be taught. Both teachers and students have the same book, from where the teacher teaches and students learn. The same is true of practical book on chemistry.

It may be also noted that sometimes the teacher may also go through different text for his own study or may prescribe different book by different authors in the class. But in the Chem. Study system, in addition to the above two books, one for theory and other Laboratory manual (for Practicals), we have one more book called 'Teacher's Guide'. The idea of the Teacher's Guide is a new experiment in the Chem. Study Programme.

Again, the sizes of three books in the Chem. Study Programme has been prepared by a committee of experts set up under a grant from the National Science Foundation.

Teacher's Guide is the main book meant for use by the Teacher only. It guides the Teacher as to what is to be taught, how a subject matter is to be taught, when

it is to be taught and the sequence in which it is to be taught. Not only this, Teacher's Guide also gives direction regarding the sequence in which experiments in the Laboratory Manual are to performed by the students. Thus Teacher's Guide is a complete key to the Text Book and Laboratory Manual (Practical Book). It gives a thorough details of every lesson, lecture, practical and experiments. It gives complete solution of various unsolved problems, questions, quiz, puzzles etc. etc. asked in the Text Book and Lab. Manual. If the teacher goes through the Teacher's Guide, he becomes the master of any situation both in the theory class and the practical class.

That way Teacher's Guide is meant for use by the Teacher. Also if Teacher finds time, he can also go through the Text Book and Laboratory Manual, which are meant for use by students. The idea of Teacher's guide is new in the American system and our Indian system, or for that reason the CBSE Scheme, New Delhi does not envisage any Book or Guide for use exclusively by the Teachers. In this connection, it would be worthwhile to make a little mention of the fact that Framers of Chem. Study System were aware of the Teacher's difficulty and they visualised it and hence they developed the Teacher's Guide. Pedagogically the idea of Teachers guide is very sound. It is so that both the teacher and students do not go through the same book i.e. the Text prescribed for the class and hence Teacher's Guides serves as an extra material for the teachers to go through it and grasp the

subject matter. Thus the teacher feels elevated when he is in possession of a book which gives a vivid details as to what is to be taught. Moreover, it is a matter of pride for the teacher to be a master of any situation that may arise and Teacher's Guide is an answer to all such situations. It puts the teacher in a superior position and gives the confidence in his teaching. Again, the Teacher's guide also gives a brief description of various films on different topics and these films being a part of Chem. Study Programme, are discussed at appropriate places in the Teacher's Guide and are a part of the chapter after which they are appended too. Thus educationally, the idea of Teacher's Guide is very sound and well versed.

CHAPTER - 4

TEXTUAL COMPARISON

INTRODUCTION

Having discussed in detail as to what chemistry tries to envisage in the CBSE Scheme and also its concept and meaning in Chem. Study Programme and gain having discussed the philosphies, the aims and objectives of the two systems, we now proceed to take up the actual comparison, topic by topic, unit by unit, chapter by chapter and so on, on bothe the systems as it is available in the texts prescribed in the two systems.

It may be noted that in case of Chemistry as depicted in the CBSE Scheme the Student-Associate had a thorough look of so many standard books (text) on the subject because of his experience as a Lecturer in Chemistry and hence no particular book is taken as a reference but this refers to the general trends of describing the subject-matter as is available in our Indian system of Chemistry teaching. On the other hand in case of Chem. Study, the one particular book; 'Chemistry; an Experimental Science' text book mainly for use by students and a part of the system called, Chem. Study, is the reference-book for this purpose.

TEXTUAL COMPARISONS:

Now we take up these textual comparisons one

after the other;

1. Structure and Nature of Flame, Luminosity of Flame; CBSE, T-15, Chemistry; An experimental science, Lab. Manual

Experiment I; Scientific Observation and Description;

In the CBSE Scheme, New Delhi or for that reason in any programme of studies in chemistry in Indian structure and nature of flame of a wax candle or that of a gas burner and studying its luminosity form an important part of the syllabus. Here in chapter 15 the topic has been discussed in the CBSE scheme of studies. The main stress is on the observation of the structure of the burner flame, its various parts or zones and its luminosity. Again, it is an experience that we, in Indian conditions, study only four zones of the flame as regards its structure and nothing is done as regards observation of the structure etc. beyond those four zones.

But in the Chem. Study Programme the very first chapter in the Text Bok; 'Chemistry an experimental science' is; 'Scientific observation and descriptions'. It is a beauty of the Chem. Study that a due stress has been laid on scientific observation and description. It is a novelty of the Chemical Education Material Study Programme. The corresponding experiment, the first experiment on scientific observation and description, starts with a

burning of a candle. It is a experiment with a difference and in fact very simple as regards its techniques - - but very significant as regards its importance. The experiment incorporates a unique kind of scientific activity. It is expected that an observer would give all kinds of details as regards his observing a burning candle. There are as many as 60 observations and this explains as to why we observe only four zones and some thing more but nothing beyond that. This explains that the experiment has a distinction from other experiments - being very simple yet full of scientific observation and activity. This leads us to conclude that Chem. Study approach is both investigatory (investigating the changes etc. in a burning wax-candle) and enquiry based. On the other hand our approach is; facts being told and listed out by the Teacher in his class-room teaching.

Otherwise too, first chapter in any chemistry book by Indian authors does not try to introduce us to any simple activity as scientific activity, as has been done in chapter I of the Chem. Study programme. In our usual conditions, every author tries to define what science, what chemistry is or it enumerates and defines various branches. But this topic i.e. scientific activity being discussed and depicted in the very first chapter of Chem. Study Programme adds to the strength of the programme. Not only this, enumeration of activities of science, observation and description, search or regularities, the example of a lost child

and the way he collects things and keeps himself warm by burning those collected articals and then examples of various objects right from simple wood piece to billiard ball etc. - all this gives novelty to the phenomenon-scientific activity. 'Wondering why' and the concept of uncertainty being explained and derived and then diagramatic sketches of all those concepts lend charm to the Programme even from the beginners point of view. This is another reason for the strength of Chem. Study Programme.

2. Three States of Matter (CBSE, T-4)

The gas phase. (Chem. Study, C-4)

Now in our system or for that reason in the CBSE Scheme, New Delhi, we lay a joint stress on the three states - solids, liquids and gases of matter. In actual practice,, in physics, we lay equal stress on the three states of matter. In chemistry, of course, the chapter still goes on by the name "Three States of Matter" but in actual practice more stress is laid on the gaseous aspect of the matter. As is clear from topic-8 (CBSE Syllabus), we teach gases, their behaviour, their general chracteristics, i.e. relations between volumes, pressure and temperature and various laws e.g., Boyl's law, Charles' Law, the combination of these two into One Equation, Dalton's law and Graham's law etc. In some cases we do lay stress on their applicational aspects too. The chapter is silent about the general properties and behaviour etc. for liquids

and solids - a thing which is dealt in physics in the CBSE system, New Delhi.

The approach is entirely descriptive, facts have been stated , laws have been enunciated, equations have been derived and mathematical formulaes of various laws deducted from logic-simple and direct. This is the picture of the chapter named above in the CBSE Scheme. Even it seems that the topic has been wrongly named;"Three States of Matter", though it deals with one i.e. the gaseous phase of the matter. This misnomer is both in the nomenclature of the subject matter (chapter itself) and the content of the chapter.

On the other hand, parallel chapter in the Chem. Study is chapter - IV: "The Gas phase Kinetic Theory". Here in Chem. Study, the chapter deals with the Gase phase" with various concepts. Here the students are introducted to volume occupied by one mole of gas, comparison of molar volumes of gases, the Avogadro's Hypothesis, kinetic theory of gases, concepts of temperature and kinetic energy, absolute temperature and lastly the concept of perfect gas. As is clear from the above two discussions, the kinetic theory of gases, the concepts of temperature and kinetic energy, we do not discuss in our Higher Secondary Scheme of Education. Also Avogadro's Hypothesis, which is a backbone in understanding the physico-chemical aspects of chemistry is exluded from the syllabus in the CBSE Scheme,

New Delhi, while the above things being as such in Chem. Study Programme. One thing which we have come across in the actual text of Chem. Study Programme is that as regards Avogadro's hypothesis, that is not described in details nor its applications in putting chemistry on firm footing as it did by over throwing Berzellius Hypothesis and further did in discriminating between 'Atom' and 'Molecule' - a land mark in the history of chemistry, is neither described nor discussed there in. The same is true of kinetic theory of gases. It is not discussed in the form of postulates (principles) in the Chem. Study text. Nor is there any derivation of common gaseous laws from kinetic theory of gases - a thing, which sets up inter-relation between the kinetic theory of gases and various gas laws, is missing. This shows loose concept of chemistry being taught in an American School, Chemistry without much cohesion and conciseness. This of course is not so in our Indian system of chemistry teaching. Of ourse, there is good descriptive and diagrammatic exhibition of the above mentioned concepts in Chem. Study - a thing, which is entirely missing in the Texts written by Indian authors for the CBSE Scheme, New Delhi.

3. Three States of Matter: (Gases), Liquids and Solids, CBSE: T-2, Liquids and solids; Condensed Phases of Matter Chem. Study, C-5;

As explained in point 2 above there is no dis-

cussion of the first two states of matter - solids and liquids. It would be apprpriate to stress the point here that a chemistry text in India does not include study of solids and liquid within its preview. These two topics fall to the lot of physics in our system. Chemistry is no way, it seems, connected with general properties and behaviour of the two states of matter. Though the chapter has been mistitled; "Three states of matter; solids, liquids and gases", yet nothing is given as an account for the two states; liquids and solids.

But on the other hand in Chem. Study Programme, chapter 5 deals with only these two states of matter: liquids and solids; condensed phase of matter. Here the concepts explained are: pure substances, liquid-phase changes and equilibrium, solid-liquid phase changes; solutions and their distinction from pure substances and three kinds of solution; variation of properties of solutions, electrical nature of matter, electron proton mode; electrical property of condensed phase and electrical conductivity of solids etc.

Now to elaborate the point, the chapter 5 deals with certain higher concepts as detailed in the later part of the above paragraph. In fact these are the processes in physical chemistry which we, in India, teach at B.Sc. level under phase rule, theory of ionisation and electrochemistry. Chapter - V in Chem. Study Text adds newness

to the programme and as such liquids and solids are described and discussed within the purview of the subject matter of chemistry - a thing still being regarded as a part of physics in our set up of teaching science. Again explanation of phenomenan like evaporation of liquids, solidification of organic liquids in iced water, heating of ice and the conductance f electric current by saltish water etc. having been explained and sketched diagrammatically in the text; is something very true, scientifically and pedagogically. In addition to liquids and solids, the chapter deals with solutions, a medium which is very important for the study of chemistry.

4. Acids, Bases and salts; Lab. Methods of their preparation, Characteristics and classification and nomenclature; CBSE, T-II/Aqueous Acids and Bases; Chem. Study, C-II;

Now in the CBSE Scheme, New Delhi ordinary course of teaching at Higher Secondary/P.U.C. level, starts with definitions of acids as substances reacting with alkalies to produce salt and water and similarly basis are defined as substances reacting with acids to give similar products. Along with that, we discuss general methods of preparation and their general properties as regards acids, basis and salts dealt as individual classes of compounds and before that the nomenclature of these classes of compounds is discussed separately.

This is our concept of teaching chemistry of Acids, Basis and Salts at higher secondary level.

On the other hand, in Chem. Study Programme as envisaged in chapter XI, the topic is; Aqueous Acids and Basis and wherein concepts like; Weak and strong electrolytes with examples, special roles of H(ag) and OH(ag) ions in water and thereby concept of Kw and then experimental introduction to acids and bases, nature of H + (ag); then finally acid-base titrations and acid-base Bronsted-Lowry concepts are the things detailed and discussed here in the text.

Except weak and strong electrolysis, or acid base titrations, or to some extent roles of H + (aq) or $\overline{\text{O}}$H(aq), the rest of concepts discussed herein in the Chem. Study Programme are above the intellectual level of learners of Higher Secondary Schools in India. Otherwise too the chapter under discussion gives a good account of various aspects of acids, bases and salts etc. Explanation of the concepts of H+(aq) or OH(aq) and that too in the form of ionic equations and balanced equilibria testifies the students previous standard of achievement in the subject. It expects students of very very good background in chemistry before one can actually follow the entire set up of the subject matter in the Ch. Study Programme.

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5. Hydrogen, Oxygen; Water Oxides, hydroxides; Oxidation-Reduction; O_3, H_2O_2 (CBSE, T-19)

Oxidation-Reduction Reactions (Chem. Study C-12)

Now in the Central Board of Secondary Education Scheme, New Delhi, topics like hydrogen, oxygen, ozone, water and hydrogen peroxide etc. have been described at length and their detailed properties incorporated. Now compounds like ozone and hydrogen peroxide, which form an important part of the above studies, behave as oxidising agents and hydrogen as a powerful reducing agent. Hence a textbook in Chemistry in the CBSE Scheme New Delhi, describes the process like oxidation-reduction in details. As oxidation and reduction are two processes which always go on side by side and proceeding of one means appearance of the other in the field of reaction, hence the two processes have been described at length and that too, together. The description covers definitions and illustrations with a suitable number of examples. The mechanism of the two processes taken has also been explained alongwith the main examples seperately and taken simultaneously. Moreover, reduction-oxidation as a process has been depicted as a part of the studies of reactions of hydrogen on the one hand and Ozone and hydrogen peroxide on the other hand. Of course, text book of chemistry under the CBSE Scheme, New Delhi gives a detailed illustration and suitable examples of the two process from the fields of other substances behaving as reducing or oxidising agents. As such the description is complete

in itself and is fully described in this particular chapter in our scheme of text books on chemistry. Explain; Redoxi

On the other had in case of Chem. Study, chapter XII describes oxidation Reduction reactions. Well here in Chem. Study Programme, oxidation-reduction has not been described as a part of the main studies of Hydrogen, Oxygen or Ozone etc. but it has been described independently. The description of electro-chemical cells preceds the main discussion of Red-ox-phenomena. Again, the concepts like 'competition of electrons', electron transfer and thereby predicting reactions, chart of metallic elements and their electronic exhibits, then concept of oxidation number and its utility in balancing Red-ox reactions and finally the process of electrolysis have been included here in the chapter under review.

The basic difference in the studies of the respective topics on the two system may be explained that "Chem. Study Programme is one based upon investigation and enquiry on the part of the learners and the CBSE approach is nothing but facts being described in logical order starting from descriptive definitions to some of the explanations of equation and mechanism of the Red-ox process.

For example in section 12-13, Chem. Study competition for electrons' is developed very beautifully and logically and the concept of electro positivity has been developed therein without giving a definition of electro

positivity as a process.

Again, the last part of the above section is developed very logically and has been much appreciated as regards its explisity etc. Moreover, the definitions of oxidation and reduction as a process are entirely missing and the way these have been given is on the basis; half reactions – a concept entirely missing in our set up at the Higher Secondary or Pre-university level.

Again, in section 12-14 operation of an electro-chemical cell and the description appended herein is something like an outstanding attempt to simplify the whole concept; operation and electrolysis brough about in a electro-chemical cell.

The predicting of reactions on the basis of electro-transfer is another novelty of the Chem. Study Programme as a whole. The diagrammatic sketch of various circuits at different points in the chapter adds to the strength of the topic under discission.

Such an approach is entirely absent from our set up of writing a text book on chemistry or for that reason from any text book on physics, mathematics or biology.

6. Chemical Equation and its significance. Chemical Calculations (CBSE T-7) Chemical calculations; Chemistry Study, C-18

Now as regards chemical calculations, it forms

the basis of development in chemistry. In Indian system of teaching chemistry, we recognise it well and a due stress and even sometime more is laid on chemical calculations. Now it is a fact that all chemical calculations are based upon the concept of a balanced chemical equation and hence in topic-7 of the CBSE Scheme, chemical calculations are grouped together with chemical equation and the solution of various chemical problems (numerical and otherwise) is based upon this.

These chemical calculations involve problems of all kinds based upon the concept of a balanced chemical equation, that of At. Wt. and Mol.Wt., Eq. wt., relationship between valency, Eq. wt. and At. wt., on that between Basicity/Acidity and Eq. wt. and molecular wt. etc. etc. All such problems including those on titrations of all kinds are included here in. In some texts in the CBSE Scheme we have got two chapters one on simple chemical calculations and other on advanced chemical problems. That way, Indian system of examination or for that reason, the CBSE scheme, New Delhi lays a due stress on the importance of the chemical arithmetic in chemistry. Even in practicals, there is a lot of calculations involved in titrational exercises or in those of gravemeteric nature.

On the other hand, in Chem. Study Programme, chemical calculations have been discussed, in not too much details, in chapter 13 - rather the shortest and smallest possible chapter. Here the calculational system described

in consists of very very brief stio-chiometric calculations and then one more principle discussed arithematically is the manufacture of sulphuric acid in the form of (i) wt-wt. calculations (ii) Wt-Gas vol. calculations. (iii) Gas vol-gas vol. calculations (iv) Wt.-liquid vol. calculations (v) Liquid vol-vol. calculations etc.

Now here the pattern of discussing these chemical calculations is entirely different from that of the CBSE Scheme. These chemical calculations are discussed not in the background of the chemical equations-which form backbone to all these calculations, nor have chemical equations been discussed elaborately where in the text earlier or even after the chapter under discussion. This naturally leads us to conclude the loose concept the students would have regarding chemical calculations. Moreover the chapter under discussion describes more in details the chemical principle involved in the manufacture of sulphuric acid and less of arithematico-chemical principle, a fact from where I could not make out whether the chapter deals with chemical calculations of manufacture of Sulphuric acid. This is not so in a textbook on chemistry in the CBSE scheme of studies. Of course, it is concluded from section 13.2-1 in Chem. Study that the approach of what has been discussed is investigatory one and not mere solutions of problems being given.

7. Distinction between organic and inorganic compounds. Elementary analysis of organic compounds

. Determination of empirical and molecular formulae from given percentage composition. Hydrocarbon (p.29, CBSE)

Chemistry of Carbon Compounds (Chem. Study, CalR.)

Now as regards the CBSE Scheme, there organic chemistry forms an important part of chemistry programme and as such introductory part of organic chemistry as a subject is being envisaged to be taught at the school final/PUC level. In our set up, chemistry is taught as a separate discipline from 9th class or first year of the Higher Secondary and now it is being recommended to teach chemistry as a separate discipline right from 6th class. Whatever is the position, sub-disciplines within the subject are being introduced at the final year of the Higher Secondary or PUC level. Sub-disciplines here in the subject being:

(i) Inorganic Chemistry
(ii) Organic chemistry
(iii) Physical chemistry
(iv) Analytical chemistry.

As such the inclusion of the above mentioned topics of organic chemistry serves a good purpose for introducing the learner to the sub-disciplinary aspects of the main subject - chemistry. At first Year of the college Degree course organic chemistry being taught as separate and distinct sub-discipline within the main discipline - chemistry. As such the chemistry course in general and organic topics (as detailed above) in particular serve as a good background for teaching organic chemistry as a separate sub-discipline at the first year of the college Degree Course. Moreover the topics

included over here serve as basis for introducing the subject. It includes the distinction between organic and inorganic compounds, elementary analysis of organic compounds, determination of empirical and molecular formulae from given percentage composition and lastly chemistry of Hydro-carbons. All this serves as a good basis for introducing the subject on logical reasoning. Topics like elementary analysis of organic compounds, their theoretical discussion of Hydro-Carbon, a class of parent compounds in organic chemistry, serve as a good tool for the beginner to learn chemistry. On the other hand, Chem. Study programme incorporates a chapter on "Chemistry of Carbon compounds", whereby the various concepts dealt in include; "Sources of carbon compound, their molecular structure, chemistry of various organic functional groups and corresponding compounds, their nomenclature, then Hydrocarbons and finally polymers including Nylons etc."

Here too the subject matter dealt in is rich and includes something far more than we have in the CBSE scheme of studies. Here in CBSE & in Chem. Study Programmes, the only difference in approach as regards 'organic chemistry is being included is that in the CBSE scheme, organic chemistry is being taught as an introduction to organic chemistry- as a sub-discipline while in Chem. Study Programme, organic chemistry or chemistry of carbon is being taught as one like that of other elements and there is no shift from In-organic

to Organic while passing from chapter 17 to 18, or for that reason there is no shift from organic to inorganic as we take up chapter 19 after 18 and so on. This lends uniformity and cohesiveness to the subject matter as discussed in the Chem. Study Programme. This continuity is available in the Text right from 1st to 25th chapter. Chem. Study Programme does not bother as regards the division of the main theme into sub-disciplines etc. It is one continuous and constant piece of knowledge being tried in the subject of chemistry. This is what the Chem. Study Programme stands for.

Not only this, but right from first to the last chapter, various topics dealt in include those from inorganic, physical organic or analytical, all of them have been discussed in one continuous manner - "Chemistry; 'An Experimental Science' and no where the penal of learned . authors of Chem. Study Programme have ever tried to classify these concepts into minuter concepts i.e., sub-disciplines. Chem. Study Programme stands for chemistry as one composite subject, as one indivisible discipline and so on. This is what Chem. Study Programme strives constantly. On the other hand, the CBSE scheme proceeds on the assumption that ultimately chemistry as a discipline has grown out of organic, inorganic, physical or analytical branches as sub-disciplines. This assumption is clearly depicted in its syllabus and the arrangement of the subject matter within the text itself. Here the two programmes differ widely as regards their approach etc.

8. Halogens: Chlorine, Hydrochloric acid, Chlorides, Bleaching Powder, NaOCl, their relationship with Cl_2 (CBSE, T-22)

Halogens; Chem. Study, Chapter-19

Now here in halogens, the CBSE scheme introduces the study of chlorine, hydrochloric acids, chlorides, $CaOCl_2$ & NaOCl and finally relationship between the halogens amongst themselves.

The syllabus is silent about other members of the halogen series or for that reason for other compounds of the rest of the three halogens. Here it would be appropriate to say that the CBSE scheme tries to introduce the learners to chlorine the first halogen and its important compounds. The study of bleaching powder shows that applicational or for that reason industrial aspect of chemistry is being exploited for the development of our economy too. Also the study of inter-relationship between the various elements of halogens group is nothing but periodic discussion of the group as a whole and the inter discussion of these elements amongst themselves.

This all is logically placed and sequentially developed.

Taking up the case of Halogens, chapter 19, Chem. Study programme deals with the various aspects; properties of the Halogens, their atomic and ionic sizes, preparation of

halogens, the idea of iodimetry, positive oxidation states of the halogens, and the concluding remarks on flourine", etc. have been dealt in the chapter under review. The chapter on halogens like other chapters does not go into details of any of the sub-concepts mentioned above. For example under preparation of halogens (all of them) only preparation of chlorine is discussed and that too from electrolysis of of moltensodium chloride and here again both theoretical and experimental details are missing. Similarly under the caption, 'properties of halogens' ,, the chemical chracteristics of this class of compound is missing, only physical properties have been incorporated. Of course, structural approach of haloxy acids and explanation of their chemical oxidation nature is remarkably discussed. Of the two schemes, it is now clear that the CBSE scheme tries to introduce the learner to the subject step by step while Chem. study does the same all in one, where it includes every aspect of halogens and misses the necessary theoratical details ever. The haloxy acids discussed here in Chem. Study programme are definitely above the level of students following science-stream at the Higher Secondary level, New Delhi.

Again in CBSE Scheme of studying halogens, inter-relationship between the various individuals is envisaged to be discussed and that is done on the basis of the Periodic Table. While on the other hand, the Chem. Study Programme does not envisage any such periodic discussion of the four

halogens but it gives the periodic table here and here in depicting distinctively the various halogens and their relationship.

S. Alltoropy, H_2S, SO_2, H_2SO_3, SO_3, H_2SO_4, SO_4 (CBSC, T-23)

P, PH_3, P_2O_5, H_3PO_4 & PO_4, PCl_3 & PCl_5 (CBSC, T-24)

Silicon; its action on bases, Na_3SiO_3, Glass Borax, Boric acid (CBSC, T-25) Cu..........Zn CBSC, T-26

Third row of Periodic table (Chem. Study Chapt.21)

Now here in the CBSC scheme the topics 23, 24, 25 & 26, all underlined above are nothing but studies of non-metallic elements like sulpher, phosphorous boron & silicon alongwith their important compounds as appended therein with each. Among the metals, Cu & Zn form the part of the course.

While discussing sulphur, allotropy, hydrogen sulphide sulphur dioxide, sulphorous and sulphuric acids alongwith their sulphites and sulphates are discussed therein. Similarly for elements like phosphorous Boron & Silicon etc. Discussion of their important compounds follows. Again taking case of sulphuric acid, here discussion has been given of the history of discovery and that of manufacture of the acid, the manufacturing processes - the contact and the chamber process, the detailed account of physical and chemical properties and finally uses, the king of the chemicals, has got and then its structure etc. has been discussed.

The same is true of all the elements and their compounds listed above. Even minutest details are given in the text prescribed for the purpose. Not only this, but even miscellaneous details e.g., SO_2 behaves as a mild bleaching agent and chlorine, as discussed in the properties of the gas, also behaves as a bleaching agent, so in CBSE scheme a detailed account of the comparison the two as bleaching agents is given under both sulphur dioxide and chlorine. While on the other hand, in the Chem. Study Programme, the parallel topic we have is the study of "The third row of the periodic table", Chapter-20. The third row includes elements like Na, Mg., Al, Si, P, S, Cl & Ar (i.e. elements No11 to 18). Thereby the various aspects discussed herein include physical properties of elements, the elements as oxidising and reducing agents, their hydroxides-both of acid character and that of basic character; occurrence and preparation of these elements and so on.

Here the 3rd row of the periodic classification is the main theme of the chapter. But in spite of that the metallurgy or the extraction of even one of these elements is not discussed in details, even their individual chracteristics have been discussed. Of course, basic conepts like Na, Mg & Al as well defined metallic solids; silicon - a network of solid, and P, S & Cl as molecular solids; then Na, Mg, Al - as strong reducing agents, Si P & S as both reducing and oxidising agents of intermediate strengths etc.

then explanation of their oxides and hydroxides as bases acids-all these concepts have been well explained and details given. Here lies the strength of Chem. Study Programme in explaining the minuter concepts with clear explicity even for the beginners.

Again, as regards occurrence of these elements or their manufacture, that aspect is awfully missing. Minerals, ores and their distinction or nomenclature or for that reason a manufacturing details of elements like - Al, which is of great industrial importance, is entirely missing.

Here it would not be out of place to mention that in case of the CBSE scheme, no important details are missing. In case of Na, for example, occurrence as ores, its extraction (or metallurgy) by both the processes - castner's and Down's cells, their properties both physical and chemical its important uses and then its very very important compounds form a sequential discussion of a text book in the CBSE scheme while all these details are missing in the Chem. Study Programme.

Again as is clear from above, compounds, their preparation properties and uses are interwoven alongwith the main element under discussion. But in Chem. Study in the whole of it, not even a single compound has been prepared, properties discussed and uses given. Here again the two programmes differ widely.

10. Na..........Al. (CHMT-26)
Second Column of the periodic Table, Chem. Study Chapter-21.

Now the next topic included in CHMT is Na and Al. Here when we have to teach Na, it includes a number of details e.g., History as to how sodium was discovered, occurrence as to how it is available in nature i.e. Native Na or its ores (sodium does not occur native) its extraction by the Castner's process and Down's cell. This includes both theorational and practical details, procedure and diagrammatic sketch of the process under discussion, then properties both physical and chemical including reactions in the form of balanced equations, its uses then last of all some very important compounds of sodium. There compounds are those which are industrially important, and they form an important a part of chemical discussion of any metal what so ever. Inclusion and study of important compounds after each element is very chracteristic of Indian way of teaching chemistry. On the other hand, the Chem. Study programme deals with second column of the periodic table, as a parallel topic, in chapter-21. The second column of the Periodic Table includes Alkaline Earths e.g. Be, Mg, Ca, Sr, Ba, Ra. Here though no periodic position of 2nd column is discussed yet the periodic table as a whole is given and the relationship of 2nd column with 1st column of alkali metals of that with third column can be easily established. Though Chem. Study Programme does not clearly mentions it. Again the various aspects dealt with

here in this chapters are Electronic configuration, trends & in physical properties, those in chemical characteristics, finally occurrence and preparation of the member elements. Now a close study of the text shows that as regards minute concepts e.g. electronic configuration or for that reason trends in properties it has been discussed very clearly and thorough ly. The explanation put forth there in is very appropriate and explains the chemical principles very well. Other under these heads, atomic radii, ionization energy metallic properties, oxidation-reduction etc. are the significant of the discussion and adds to the strength of the subject-matter. But finally when we go through occurence and preparation as discussed therein of these member elements, we miserably fail to find anything. All these are well defined metals and their metallurgies form a glorious chapter in chemistry but that all is missing. Not even a simple metallurgy is described. 'Chemistry text book without any details of even a single metallurgy I as a student of chemistry and thereof science education could never visualise such a text. But this is truely so of Chem. Study Programme.

This definitely puts Chem. Study Programme in inferior position compared to a text in the CBSE Scheme. Reasons are obvious. The inclusion of minute chemical principles and exclusion of metallurgical details respectively account for the strength and weakness of the Chem. Study Programme.

Again concept of ionic radii and before that atomic radii and then cubic structure of Cu & Zn – all this being explained diagrammatically adds to the minuteness of the subject and makes the study very subtle. But all this is missing from a text in CBSE scheme because of simple reasons of not being in course of studies and moreover, these concepts have been thoroughly discussed in a text of B.Sc. classes. It is little beyond the comprehension of students of Higher Secondary level.

11. Cu——————Zn——————Fe (CBSE, Topic-26)

Fourth Row of Transition Elements (Chem. Study Chapter -23).

Now as discussed earlier, whenever any metal is described, various aspects of its chemistry are given a due weight – age each in the CBSE scheme of studies. For example, the chemistry of Iron is taught by starting with its history, its old-time use in India, its manufacture by TISCO, IISCO, and the modern steel plants set up with foreign collaboration. After that its metallurgy and a beautiful description of Blast Furnace, then the manufacture of stell, the three varities of iron, its physical and chemical properties, its uses and then its important compounds and lastly how iron gets corroded and chemistry of rust is discussed. All these details form an important part of the discussion of Iron in the CBSE Scheme. The same is true of Cu and Zn at their respective places in the scheme of

Central Board of Secondary Education, New Delhi.

On the other hand, the parallel chapter in Chem. Study Programme deals with the transitional elements i.e. elements of the 4th row of the periodic table. It includes the study of 1st ten elements forming the transition series. The elements included are from Sc-21 to Zn-30 and the textual details are definition of transition elements, the complex ions coloured ions they produce then specific properties of the 4th row of elements ie. coloured salts, paramagnetic nature and then a brief account of all these ten elements one after the other. The detailed study of the text has revealed that all possible subtle concepts have been elaborately explained and individually clarified. The atomic sizes, the ionic sizes have been graphically depicted. Various equations incorporated are based upon electronic concepts of the elements involved. Lastly manufacture of iron, its corrosion and how to prevent the same has been vividly described. As regards its manufacturer, only physico-chemical explanation has been put forth and various chemical equations have been given in set order, but its experimental details, theoretical details and the actual process on the blast furnace all these are missing. Also compounds - coloured and as such distinct - of these elements have not been discussed any where in the text. Of course, energy level diagram, tetrahydral and hexahydral structures of various molecules of elements has been thoroughly discussed diagramatically too. On the whole the chapter described

various minute details but at the same time it misses a lot of important things, the most important of which are metallurgical details and studies of compounds.

General Observations regarding textual comparison of the Elements in the third row, 2nd column, forth row of the Periodic Table as envisaged in Chem. Study Programme and corresponding items dealt in various topics of CBSE Scheme

Now here we try to depict the various points. Firstly the Chem. Study Programme has not dealt with periodic law or Periodic Table vis-a-vis the periodic position of these elements as enlisted above. In other words, the comprehensive description of the periodic law and the Mendeleef's Table, it seems, is not found any where in the Chem. Study Programme. Hence it is but clear that where the Chem. Study takes up the discussion like 'Third Row of the periodic table or Second column of the periodic table or for that reason of 4th row of the transition elements etc. they are not well fitted in the text in the sense that before that zero group or first column and then first group of alkali metals etc. have not being dealt earlier. If at all there is any mention of alkali metals, it is entirely in different context and hence the discussion of these topics as such is not pedagogically sound. On the other hand, the CBSE Scheme, New Delhi but incorporates a separate chapter dealing with the Periodic Law and Periodic Tabl and it is not expected from students to discuss the periodic position of certain groups or periods in the CBSE scheme. On the other hand, Chem.

Study programme does not give any separate discussion on periodic law but incorporates the periodic discussions of certain Columns & Rows of elements. That way, it again concludes to the loose concept of chemistry being studied and taught in an American School. Indian system stands for regularisation and systematisation of things and it follows a set sequence or order in dealing with various topics while Chem. Study does not bother much about these minuteness and even fundamentals are missing.

CHAPTER - 6

CRITICAL SURVEY OF TOPICS EXCLUSIVELY DISCUSSED IN THE CBSE SCHEME NEW DELHI BUT NOT INCLUDED IN CHEM. STUDY PROGRAM

As discussed in chapter I, there are some topics, which are common to both the systems i.e. the CBSE and the Chem. Study. Then there are topics which are exclusively in the syllabus of Central Board of Secondary Education, New Delhi but not included in Chem. Study Programme. In the previous chapter a detailed discussion of topics common to both the CBSE and the Chem. Study Schemes has been given. Here in the present chapter, we take up the critical survey of those topics which are exclusively found in the syllabus of the CBSE Scheme, New Delhi.

It would not be out of place to mention here that in the CBSE Scheme, the framers of the syllabus have tried to present the subject as a separate discipline and as such the effort has been to introduce the learner to the subject matter as sub-disciplines e.g. 'general and physical' chemistry, 'Inorganic' (Non-metals), as inorganic (metals); 'organic chemistry' (elementary form).

This division of the chemistry (as a discipline) in to sub-disciplines is clearly depicted in the text, wherein all the topics have been classified under one or the other sub-discipline throughout the text in the CBSE Scheme. On the other hand there is no such division or classification of topics into sub-divisions throughout the Chem. Study Programme.

Rather it deals with chemistry as a discipline in one continuous form, while the CBSE Scheme deals with it as three sub-disciplines as indicated above.

This is a striking difference in approach in the two projects.

Now we take up the critical survey of the topic one after the other exclusively discussed in the CBSE Scheme and not included in Chem. Study Programme. The line of action of discussion is the same as in the previous chapter and it follows the sequence as set in chapter I.

We take up these topics one by one;

1. General & Physical

1. Chemical Change and its characteristics, distinction from Physical Change; conditions that influence Chemical Action; Chemical Affinity, different kinds of Chemical actions, Elements, Compounds and Mechanical Mixtures;

Physical and Chemical change:-

This forms an introductory chapter in any programme of Chemistry syllabus at the higher secondary stage throughout the country. Here the simple division of changes into physical and chemical, conditions under which a chemical reaction proceeds and is influenced and various kinds of chemical reactions, the meaning and concept of affinity as it fits in chemical sense and finally the definitions and significance of elements, compounds and mechanical mixtures - all

these sub-concepts are discussed therein.

Thus the chapter deals with chemical terminology and introduces the learner to various modes of chemical action and phenomena connected thereof. It is a step towards learning chemical language.

Thus the set up is very systematic and lays a sound foundation to the subject as a whole. On the other hand in the Chem. Study Programme some of these concepts have not been included and those included are so in different context. While in Chem. Study there is no mention of the term mechanical mixture, leave aside the later's distinction from chemical compound. The distinction between chemical compound and mechanical mixture is of minute importance and the CBSE Scheme lays a due stress on it, while Chem. Study is silent all about the concept as given above.

2. The Atmosphere: The nature of air: air a mixture, the part it plays in chemical changes, its relation to plants and animals.

The atmosphere surrounds the earth. Air plays an important part in our life and in that of other animals and plants. It brings out certain chemical, biological and physical changes and finally air is composed of two prominent gases one out of which by itself is indispensible for life in both animals and plants - all these sub-concepts are discussed together in one chapter: 'atmosphere' and it is justified to include the same in the CBSE Scheme. The justifi-

cation is further elaborated by the fact that the earth is surrounded by air, it plays a prominent role in our life.

On the other hand, the Chem. Study Programme it seems does not discuss some of these concepts at all. Whatever is discussed in the last chapter in the Chem. Study Programme is under a different context. Air with respect to Chemical changes and in relation to animals and plants does not fall within its purview.

3. Water; Hard and Soft Water; water as solution saturated and super saturated solubility, decantation, filtration, evaporation, distillation and crystallisation

Water is an important constituent of life. It is as important for both animals and plants as air. Hard and soft water - an important aspect of chemistry of water, important from the points of view whether soap being soluble or giving curdy white precipitates in water and also equally so because of its use in boilers - where large amount of steam is drawn and used industrially-all this is very important for the learners to know about and the CBSE scheme makes an elaborate mention of the same. Discussed after that in the chapter under discussion are solutions in water, their decantation, filtration, evaporation, distillation, crystallisation etc. All these are chemical operations to which solution is subjected at one or the other moment. All these

chemical operations are very important from the points of view of the beginners. Children learn from simple procedures and these simple chemical operations which involve simple principles are very important from the points of view of the young students. Hence the CBSE scheme is justified to introduce the young students opting for chemistry to learn a lot from these chemical operations and water-hard and soft. The later has got an industrial aspect in addition to the chemistry involved therein. Hence the CBSE scheme makes the best use of that. But on the other hand, in Chem. Study, we do not find any treatment like water-hard and soft or that dealing with simple chemical operations as discussed therein in the CBSE Scheme. Though Chem. Study does not miss any process or principle which has got industrial importance, yet it is silent about hard water as regards its use in boilers and the wastage of soap it causes if used for washing purposes. Chem. Study has not included this aspect. Again, simple chemical operations like evaporation are also missing from the text in Chem. Study Programme through these operations later on become of industrial importance, yet it seems the Chem. Study Programme does away with it.

4. Methods of purification of substances and separation of mixtures: Sublimation

Many Chemical operations (as mentioned earlier) Here again while purifying substances, chemistry comes to our rescue. It is these chemical operations alongwith sublimation, which a chemist uses while purifying or separating

two more substances mixed together. Later on these simple operations whih the students learn here in the beginning find an intensive use in some metallurgical and other industrial processes. Thus the fundamentals of those operations learnt over here in the beginning become a part of his knowledge, when he comes out to be a chemist in life and uses these principles with ease and profit in industrial processes. This idea of teaching simple principles and later on their uses in industrial processes is well depicted in the scheme of CBSE and the CBSE proceeds on these assumptions that ultimately chemistry is to the used in Industry.

On the other had in Chem. Study Programme, as we go through the text we find that it is a chemistry meant for Industrial Chemists, yet to some extent it ignores various chemical operations and the principles involved therein. Though ultimately it is these principles which find industrial uses in various processes, yet some of these are missing from the Chem. Study Programme.

5. Dalton's Atomic Theory and Laws of Chemical Combination:

i) Law of conservation of mass
ii) Definite proportions
iii) Multiple proportions
iv) Equilent or reciprocal proportions
v) Gaseous volumes.

In our scheme of teaching chemistry, Dalton's Atomic theory forms the backbone of chemistry as a subject.

Dalton's Atomic Theory is very important from the point of view that it tries to theorise the very nature of atom and it is forerunner in the field, as regards the historical prospective of the words 'atom' and 'compound-atoms'. The theory being put forward as early as 1808 and that too by John Dalton, an English school master, it itself is a history. So from our point of view, when we lay great stress on historical back ground of various chemical inventions, the inclusion of the 'Dalton's Atomic Theory' is a must in any scheme of teaching chemistry. Not only this that Dalton's Atomic Theory has got a history, but also it is important from various other angles. For example various laws of chemical combinations which have been put forward from time to time by different workers in the field - all these laws can be easily explained in terms of one or the other postulates of Dalton's atomic theory. Not only we can explain these five laws, but we can also derive all these laws from one or the other postulate of the atomic theory. This is a hallmark of the atomic theory itself. All this gives an extraordinary importance to Dalton's atomic theory and the laws of chemical combination. The CBSE Scheme recognises all this and incorporates teaching of Dalton's atomic theory and all the five laws of chemical combination and derivation of these laws of chemical combination and derivation of these laws from the theory itself. It gives an ample practice to students of chemistry to learn about such relationship of derivation at an early stage. All this is pedagogically very sound.

But on the other hand, Chem. Study Programme is silent about the detailed treatment of the Dalton's Theory on its postulates. It just explains the three laws of Chemical combination and tries to deduce the atomic theory from there in a roundabout manner. Moreoover law of conservative of mass is not discussed in correlation to Dalton's theory nor its derivation from the theory attempted also, the law of reciprocal proportions is missing from the text.

6. Atoms, molecules, chemical symbols and valency formulae: molecular, emperical and structural

7. Chemical equations and its significance

All these sub-concepts are very simple but they are all of far reaching importance in understanding chemistry. Symbols, formulae and equations - all these sub-concepts constitute the so called 'language of chemistry(. Throughout the study of chemistry, we make use of these concepts with ease and profit. The language of chemistry has got a uniqueness in itself. A symbol represents an atom both qualitatively and quantilatively, a chemical compound is represented both in qualitative and quantitative sense by a chemical formulae and the chemical equation is nothing but qualitative and quantitative representation of a chemical reaction. Here lies uniqueness of the language of chemistry. Not only this, but concepts like 'atom', 'molecule', 'chemical reaction', their significance, emperical and structural formulae, then essentials of an equation, its limitations and then finally the information

and chemical equation conveys - all these are very important from the chemist's point of view. The CBSE scheme of studies in chemistry only recognises this importance of the language of chemistry and incorporates these concepts very nicely in the text. This adds to the strength of the CBSE scheme. It is very essential that the student who takes up chemistry as a separate discipline is well acquainted with its language - the language which is to be used later on in the study of the subject. This is well depicted in the CBSE Scheme as there are two chapters in the text devoted to the language of chemistry, as is clear from above.

But on the other hand, concept as important as language of chemistry is not given elaborately, that of valency with respect to writing of formulae etc. then that of emperical and structural formulae and finally the implications of a chemical equation, its significance and the information it conveys - all these sub-concepts are not discussed in Chem. Study.

8. General Properties of Gases; Laws governing gaseous behaviour; e.g. Boyl's Law, Charles' Law, Dalton's Law of Partial Pressures, Graham's Law of gaseous diffusion and gaseous diffusion and liquid gases

Out of the three states of matter, gaseous state and laws governing gaseous behaviour fall within the purview of chemistry. That is why in our CBSE scheme of studies, a separate chapter deals with general properties of gases and then various laws governing the behaviour of gases. All these laws study the gaseous behaviour in their

different perspective taking various constants like volume, pressure and temperature into consideration or other gaseous properties like partial pressure or diffusion etc. are also taken into account. All these gas-laws, though very simple, have reaching significance in the study of gaseous state and ultimately prove to be an asset to a chemist, when he uses them industrially.

The CBSE scheme of studies in chemistry recognises this and gas laws have been discussed accordingly. But the Chem. Study Programme gives a roundabout and scattered picture of the gas laws. Graham's Law of diffusion is excluded from the treatment of gas behaviour.

9. Molecular weight: Definition, application of Avogadro's hypothesis in determining Molecular weights of volatile substances by Victor Meyer's method.

10. Equivalent Weight and Atomic weight: Definitions and simple methods of their determination.

The terms like atomic weight, molecular weight and equivalent weight have a special significance in chemistry. They are very frequently used in chemical calculations. Rather all chemical calculations revolve round them in one or the other form and make use of them intensively. Chemical calculations means calculation of or application of either two or more "weights". Their definitions have a meaning when we take H having a unit weight or Cl having 35.5 or C being taken 12 units or O being taken 8 units (in Eq. wt.) and 16 units (in Mol. wt.). All this is very interesting in addition to being chemically useful.

Again, various methods used or described to determine atomic weight, equivalent weight or molecular wt. or the law or the principle involved in these determinations or calculations add to the knowledge of the learner and make the subject matter very rich.

While carrying in actual determinations of these 'wts' or doing these calculations, we come accross "Victor Meyer's Method'. Cannizaro's Law, Dulong & Petit's Rule or Faradary's law of Equilance - all these are of significance and depict one or the other chemical principle - hence they have a meaning for a beginner in chemistry and hence all these are well placed in their respective chapters in the study of chemistry in the CBSE scheme. On the other hand, the Chem. Study Programme is definitely silent over such fundamentals determinations that of these 'weights', which form a pillar to all chemical calculations whether carried out in the CBSE Scheme or in Chem. Study Programme. Moreover the term equilent weight has not been introduced any where in the Chem. Study Programme.

11. Acids, Basis & Salts; General methods of their preparations, their general characteristics, classification and nomenclature.

When an acid reacts with a base (for an alkali - to be more precise), it results in the formation of a salt and water. Thus the study of an acid, a base and a salt is nothing but study of chemistry itself. Moreover the nomenclature of these series of compounds, their

methods of preparation and their general characteristics are nothing but individual chemical reactions, which by themselves constitute the fundamentals of chemistry. Hence their inclusion in the scheme of the CBSE syllabus is well justified.

But the Chem. Study Programme does not bother itself regarding these fundamental reactions how salts are formed and their nomenclature classification and kinds as these details are not discussed in the text of Chem. Study Programme.

12. Relations between Molecular weight & Equilant weight through acidity/basicity, Determination of Eq. wts. of acids/basis by volumeteric method.

Molecular weight of a substance and its equilant weight are related to each other through acidity, if the substance is acidic in nature. The relationship is through basicity if the substance under study happens to be basic or alkaline in nature.

Mol. wt. = Eq. wt. x Acidity
(for acidic substances)
= Eq. wt. x Basicity
(for basic substances)

This relationship has actually been set up and finds intensive application in calculation of equilant weight of acids/basis or in other chemical calculations. Before that, the concepts like acidity in terms of number of replaceable H-atoms, or that of basicity in terms of number of replaceable OH-radicals – all these are made clear before proving or deriving the above relations. All this is of minute

importance and hence adds to students chemical vocabulary. The CBSE Scheme keeps all these factors in view and a separate chapter deals with these concepts. Moreofer, the application of these relationship for determining equilant weight has got extra advantages.

But, on the other hand, the Chem. Study Programme, it seems does not bother itself regarding these concepts and is all silent about them. Moreover, as mentioned earlier, the Chem. Study Programme has not defined the term equilant weight, leave aside its relationship with molecular weight through acidity or bacicity.

13. Electrodysis; Faraday's Law and application of electrolysis - Explanation of terms; acids basis and salts.

Electrolysis is an important physical process involving chemical principles. The various terms e.g. electrolyte, non-electrolyte; ion, anion, cation, electrode, anode, cathode, electrolyte and conductors - all these are very important both from the point of view of learning chemistry and from that of its applicability in Industry. Then two laws of electrolysis as put be forward by Michael Farday and their application i.e. knowledge of electricity being used in the study of chemistry lays a good foundation to the inter-applicapability of one science being used in the other and vice-versa. Moreover, explanation of the terms; acids, basis and salts in terms of electrolysis adds to the strength of the CBSE Scheme, as it incorporates the same in toto as discussed above. While the Chem. Study does so in different

context and is not so explicit in its explanation as the CBSE Scheme is though the process of electrolysis is of industrial importance, yet the Chem. Study discusses it it in different context, different from that in the CBSE Scheme. Also the Faraday's Laws have been explained (but not stated) and that too to explain atomic theory.

14. Ionic Theory; Its application to the explanation of terms acids, basis, salts, neutralisation, precipitation (solubility products), electrolysis and hydrolysis

Ionic Theory as put forward by Svante August Arrhenius is one of the latest land marks in the history of chemistry. Its significance was well recognised when it explained the processes like electrolysis and hydrolysis in terms of free ions available in aqueous solution and then subsequent explanation of terms like precipitation and neutralisations, acids, basis and salts all this is new and new in terms of 'ions'. The 'Ionic theory' contra-dicted the fact that the passage of electric current brought about decomposition; an idea which was well accepted and it was ionic theory, which gave a jolt to the old prevailing idea. Accordingly the function of an electric current is to direct the two types of charged ions already available to their respective electrodes and its function is merely that of direction and not of decomposition of ions. Ions exist and come into existence by the process of solution formation. This is the strength of theory of ionisation and is well depicted in the syllabus of the CBSE scheme.

Chem. Study Programme does not deal with it

like wise. It does not discuss ionisation to explain electrolysis and vice-versa.

15. The Structure and Nature of the flame - Luminosity of the flame.

A flame is used for heating etc. in various processes of chemistry. A flame has got a distinct nature and a peculiar structure. Some flames are luminous and others are more so. The CBSE scheme of chemistry study incorporates all these sub-concepts and student is supposed to have the bits of knowledge regarding these sub-concepts. The flame he uses so often for warming/heating purposes, its nature and structure he must known. Chem. Study does not recognise this accordingly, but it does some more in different fashion.

16. Catalysis, Catalytic agents, their mode of behaviour mechanism and application

The agency of catalysis, that of promotion and of poisoning are various factors, which decide about the speed and completion etc. of a chemical reaction. These are very important processes involving physio-chemical principles. Besides, their industrial importance is well recognised. Mechanism of these reactions form a very interesting chemistry by itself. Hence the CBSE scheme includes the study of catalysis.

The Chemistry Study Programme does not mention it in details as compared to the same in the CBSE Scheme. It does so to explain rate of chemical reaction and also it gives some aspect of enzyme, which we do in Chem. Study at higher level.

CRITICAL SURVEY OF TOPICS DISCUSSED EXCLUSIVELY IN THE CBSE SCHEME (CONTINUED)

As explained earlier, while taking up the critical review of those topics exlusively discussed in the CBSE Scheme, New Delhi that the scheme under discussion deals with Chemistry as various sub-disciplines, we now take up those topics which fall under (1) Non-Metals (2) Metals (Inorganic) and then organic compounds.

II - INORGANIC (NON-METALS)

17. Characteristics of Metals and non-Metals. The Periodic classification of elements

In the CBSE Scheme, Chemistry is studied as inorganic and organic etc. branches. In the inorganic section, we come across two types of elements;

(i) metals and (ii) non-metals

Hence the CBSE Scheme envisages that the general chracteristics of these two types of elements are to be studied at length. The chapter is devoted to the general properties - physical and chemical - behaviour and chracteristics of the two classes of compounds. While carrying on the broad survey of the two types of elements, we come across borderline cases which are neither metals nor non-metals and we thus introduce them (the students) to the new class of elements called metalloids, which have got properties in between the two. Not only this, here in the chapter under review we

introduce to our students the terms alloys and amalgams etc. too. All this is new and meaningful to the students who take up chemistry as their career. Hence the CBSE Scheme, New Delhi, incorporates the same as such. But on the other hand, Chem. Study Programme does not bother itself with any such discussion of elements into metals and non-metals, nor it is concerned anyway with the study of metalloids etc. Alloys are mixture of two or more elements and have got industrial importance and the Chem. Study Programme gives an advanced bits of knowledge but elementary treatment is missing from the Text.

Periodic classification of elements:

The later half of the chapter under review deals with the Periodic law, as put forward by Mendeleef and gives the historical survey as to how from simple classification of elements into metals and non-metals, we reached at the modern periodic law and then 'groups' and 'periods'. It traces the historical development of the Mendeleef's law. It further gives detailed account of the law, the actual periodic classification, the merits and demerits of the present classification etc.

It introduces the beginner to learn about 104 elements in the form of eight 'Groups' and seven 'Periods' only. It is a beautiful attempt to have condensed the knowledge of 104 elements into eight groups or seven periods.

Students appreciate the same. The CBSE Scheme recognises all this. But in case of Chem. Study, the periodic table is discussed in a different context. There is no elaborate discussion of the Periodical Table as such for the purpose of introducing the beginner to the Periodic law as has been done in the CBSE Scheme. Moreover chapters 6 and 15 respectively are 'Structure of Atom' & the 'Periodic Table' and 'Electrons' & the 'Periodic Table', where of course the study of the periodic law fits in very well, yet the fundamentals are missing. Similarly, in chapters 20,21,22,23, we have elaborate discussion respectively of the third row, second column, the fourth row and then some 6th and 7th row elements. Before that the chapter 19 deals elaborately the case of halogens. All this is good and elaborate but this is different from the way we discuss it from our point of view. The novelty (I call it) of the Chem. Study Programme is that though all these eight chapters have been devoted to the Periodic table, in one or the other form yet the periodic law as such has never been stated anywhere in the text. At least this is not so in case of the CBSE Scheme. Here things are well-set and pin-pointed and not vague and in a round about manner as they are in Chem. Study Programme. The Chem. Study Programme is verbose and wordy in its approach.

10. Hydrogen, Oxygen; Water, Oxides & Hydroxides, Ozone, Hydrogen peroxide

Hydrogen and oxygen are the two key elements. They form a very important compound; water, which plays a

prominent role in our life and that of other animals and plants. Besides, ozone, hydrogen peroxide, hydroxides are other series of compounds which these two elements form. Oxides are the compounds of oxygen with other elements (metals to the more specific), (Hydrides, not included in the present syllabus are parallel compounds which hydrogen forms with metals). The two key elements and their compounds all have a very interesting chemistry. Hydrogen is the first and the lightest element. It is an inflammable gas and is an important constituent of hydrocarbons, acids, bases and fats etc. It is a commodity of industrial importance and hence manufactured by various methods, the most common being from water by electrolysis, where electricity is cheap. The method gives oxygen as a by-product. Preparation of hydrogen from metals by their action on water, from acids and alkalies, properties and chemical reactions of the gas, study of its various forms and then of its isotopes and finally its uses-all these are very interesting from the learners point of view.

Oxygen is an important constituent of animal and plants life and it forms about one-fifth of the atmosphere. Its preparation, manufacture, physical properties chemical characteristics, uses etc. are very important and students find them very interesting.

Water is a chemical compound composed of oxygen and hydrogen in the ratio of 1:2 by volume and 8:1 by weight. The study of synthesis and analysis of water by those ratios is very interesting for young learners. Again water being a universal solvent and itself contains dissolved salts which make it hard and as such the hard specimen of water produces not lather but curdy white precipitate with soap and then use of hard water in boilers – all these are very intresting bits of knowledge about water, which a student learns in chemistry and chemistry alone.

Ozone and hydrogen proxide are compounds which behave both as oxidiging as well as reducing agents and form a very interesting chemistry by themselves. Besides, the manufacture of O_3 and uses of these compounds are equally important. Hydroxides as the name suggests are compounds of hydrogen and oxygen with a metal. The water soluble hydroxides are termed as alkalies, the metallic hydroxides insoluble in water and called bases, all such classifications are very interesting and have meaning for the young students.

The CBSE Schemes of studies recognises this as such and all these discussions are incorporated therein in the text.

On the other bad, the Chem. Study course does not bother about such details of these important gaseous elements nor is there any chemistry of their important compounds. Even water which is very common and then hard and

soft water, which are equally important from the point of view of washing etc. - all these discussions are excluded from the Chem. Study. While the CBA scheme lays a due stress on the all these details, the Chem. Study Programme safely does away with all such important details.

20. Nitrogen, its oxides; ammonia, nitric acid and nitrates; N_2-Cycle, Fixation of Atmospheric N_2 & Fertilisers;

Nitrogen is 80% of the atmosphere. Its important compounds; NH_3 and HNO_3, have got their own uses. NH_3 is an important constitutent of the fertiliser and forms a backbone to this industry and for the progress of agriculture. Besides, it is used in producing cooling effects. Nitric acid is important as an acid, it is used to prepare various explosives, and its nitrates are useful as fertilisers - INDIAN salt-peter and chile salt-peter are the two old common nitrates of alkali metals.

Again, cycle of nitrogen and fixation of nitrogen both these processes have got their own significance, the later being important from the economy point of view, as here we produce compounds with industrial uses and both being significant as regards their chemical details.

Fertilizers have aplace in our national economy and they help to solve food problem. Fertilizers are chemical compounds and their manufacture is a commercial process.

The CBSE Scheme has done well by including all these discussions but the Chem. Study lacks all such details. Even explosives and fertilizers, which have their obvious importance, are entirely excluded from the textual discussion in the Chem. Study Programme. Though the Chem. Study Programme does not give these details as above, yet it gives the physico-chemical principles involved therein in the manufacture of NH_3 by the Haber's process or that of HNO_3.

21. Carbon Dioxide and Carbonates:

Carbon Monoxide C-Cycle in nature

The inorganic section of the CBSE scheme includes discussion of carbon dioxide, carbonates, carbon monoxide and C-cycle in nature, while the organic section deals with hydro-carbons, their general methods of preparation and general characteristics etc. and a lot of other organic compounds. Carbon monoxides and carbon dioxide are the two gaseous products which carbon is known to be having and carbonates are the metallic salts of carbonic acid with metals. Carbon cycle in nature has got its own significance to a chemist. All these are discussed as such in the CBSE Scheme of chemistry and the Chem. Study Programme lacks this all in its own way.

22. Hydrochloric acid, metallic chlorides; $CaOCl_2$, NaCl

While the Chem. Study discusses the Halogens

in chapter 19, it does not include the corresponding hydra-halo acids or for that reason the metallic halides. But the OBSE scheme includes the study of Hydrochloric acid, the metallic chlorides and then that of oxy-chlorides in the form of bleaching powder and sodium oxychloride. Bleaching powder is not a true oxy-chloride but it is a salt of two acids; HCl & HOCl with Ca^{++} as the cation. While taking up $CaOCl_2$, its manufacture, its chemical properties and bleaching process for bleaching cloth etc. are fully discussed in the OBSE scheme. Bleaching is a commercial process and is fully discussed herein in the OBSE scheme.

20. Allotropy, hydrogen sulphide, sulpher dioxide, sulphorous acid & sulphites, sulphuric acid & sulphates

Allotropy is a phenomena by virtue of which an element exist in two or more than two forms which are physically distinct but chemically same, the two or more form being called allotropes. The phenomena of allotropic modification is found in carbon, sulpher and phosphorous etc. The various forms are broadly classified as crystalline and non-crystalline (or amorphous etc). Sulpher exhibits this property and details are given accordingly in the text (The OBSE scheme).

Hydrogen sulphide and sulpher dioxide are compounds with their own characteristics. H_2S and Kipp's apparatus are very common in chemistry laboratories in India.

It brings about the precipitation of the cations of the second and the fourth groups of Basic Radicals in acidic and alkaline media respectively. SO_2 is a bleaching agent with distinction different from Cl_2, which brings about strong bleaching.

Sulphurous acid and sulphites have their theoretical importance.

Sulphuric acid is a king of chemicals and tops the list in its uses. Its manufacture by both the lead chamber process and the Contact process has got a history. The consumption of the chemical in a country is an index of her economic advancement. Moreover, its metallic salts i.e. sulphates have their own uses. The CBSE scheme proceeds on these assumption and gives an elaborate discussion of this all accordingly, while Chem. Study Programme very nicely omits all these topics. Physico-chemical principles involved in the manufacture of the acid are, however, explained nicely.

24. Phosphine, phosphorous pentoxide, phosphoric acids and its sodium salts. The chlorides of Phosphorous

Phosphine is a important gas similar to ammonia. It also differs from ammonia in some respect.

Phosphorous gives a variety of oxides and these oxides being soluble in water produce a series of acids. Out of these oxides and acids, P_2O_5 and H_3PO_4 are

prominent compounds and their sodium salts—all these have an interesting chemistry. In addition to this, the two chlorides, tri-chloride and penta chloride of phosphorous are equally interesting. The CBSE scheme discusses all these as such and the Chem. Study Programme discusses all this in a scattered, roundabout and not in very details about phosphorous and its oxy-acids. Its allotropy, match industry based upon the use of phorous etc. - all these are missing.

26. Action of silica upon bases, sodium silicate, glass, borax and boric acid

As Carbon occurs widely in the plants and animals' world, Silicon has got equally prominent position in inorganic world, where it constitutes more than 75% of the earth's crust. The wide importance of silicon is recognised by the CBSE scheme and discussed accordingly in the pages of the Text described for the purpose.

I In addition to that glass industry has got its own history and chemistry. Boric acid and borax are the important compounds of Boron described here in.

While all such details are given in the CBSE scheme, the Chem. Study Programme is characterised in its own way to give a roundabout and scattered details of all these sub-concepts. Moreover, glass, which is indispensible as regards its very many uses and is a chemical product of commercial importance, is missing from the textual discussion in the Chem. Study Programme. The same is true of borax and

boric acid as regards their omission from the Chem. Study Programme.

III - INORGANIC (METALS)

26. Ag. Hg. Pb.

As pointed out earlier, detailed study of certain metals is the distinctive feature of the CBSE scheme. Here for example in case of silver and for that reason for all metals, we discuss its history, occurrence in the form of ores, metallurgy and the various steps involved therein, its physical and chemical properties, its important compounds and finally uses of the metal under discussion. This is the general theme for all discussion of the metals dealt in herewith.

Silver is known since ages and its ornaments are very common amongst our womenhood. It finds very many other uses. This is equally true of Hg (the only liquid metal) and Pb as regards their utility. Hence the CBSE scheme deals with the metals accordingly, while the Chem. Study Programme does not give such details. Again, alongwith these metals we discuss their important compounds and photography, while the Chem. Study Programme is silent all about this. Again photography, an important chemical industry is also missing.

27. Alloys and their importance, qualitative composition and uses etc. of the following: Bronze, Brass, German silver, Bell-Metal, Type-Metal, Dural-umin and Magnalium

As discussed earlier in section 17, of the present chapter, alloys and mixture of metals and have got certain advantages over metals alone as regards their uses. The alloys named above are studied in details as regards their composition and uses and these alloys have industrial importance. The art of obtaining an alloy from the two or more metals is very meaningful to students and hence all this forms the part of discussion in the CBSE scheme, while the Chem. Study course exclude these discussion and gives only the physico-chemical explanation of alloys in general.

28. Study of the following compounds;

NaOH, Na_2O_2, $NaHCO_3$, NaCl, Na_2SO_4, $Na_2S_2O_3$,

$NaNO_2$, NaNO3 & Na_3PO_4,

KCl, KBr, KI, K_2CO_3, KNO_3;

AgCl, AgNO3 (and Photography);

$CaCO_3$, CaO, $Ca(OH)_2$, CaC_2, $CaCl_2$, $Ca_3(PO_4)_2$

and plaster of Paris;

ZnO, $ZnCO_3$, ZnS; Hg_2Cl_2, Hg_2O, $HgCl_2$;

$Al(OH)_3$, Alum; "oxides of lead, white lead;"

$FeSO_4$, Ferric alum, Rusting of Iron.

All these compounds are discussed as regards their preparation, properties and uses. These compounds have got very many uses in medicine, art, industry, painting and so on. Again photography is a profession which has been adopted by many

and it is rather an industry which gives wide employment opportunities to so many.

Rusting of Iron is a national problem not only with us, but wither nations too. How much iron is being corroded and rusted every year is a problem, which faces the chemist. Here while discussing 'rusting' the CBSE scheme also gives preventive method to controle rusting. All this is useful for students of chemistry. But the Chem. Study discusses only corrosion and rusting in details but not other compounds as detailed above. In fact the Chem. Study Programme does not give any details of the chemical compounds, which so ever. Otherwise, these compounds, their preparation, properties all have interesting chemistry and then their uses in our day to day life adds to students knowledge and hence the CBSE scheme of studies in chemistry makes the best use of them, while the Chem. Study is all silent about it.

IV - ELEMENTARY ORGANIC COMPOUNDS

Having discussed the physico-chemical principles and then Inorganic Chemistry in details, we take up a few elementary organic compounds.

29. Distinction between Organic & Inorganic Compounds

Organic compounds are a class of compounds in which the predominance is that of carbon. Carbon is known to have a unique property of giving linkage--straight chain and closed rings and as such it gives a very large number of compounds. All such compounds are called organic compounds.

While compounds other than of carbon, in which there is no long linkage and which contain predominantly others elements are called inorganic compounds. The CBSE scheme tries to draw thus line of demarcation between the two classes of compounds. On the other hand, the Chem. Study Programme does not give any such distinction what so ever worth its name.

30. Elementary analysis of Organic Compounds. Determination of empirical and molecular formulae from percentage composition

This constitutes the physical and general introduction to organic as a sub-discipline. Here it is essential that students should know the technique of analysing these compounds and also that of determining their empirical and molecular formulae, which ultimately leads to their structural formulae.

The CBSE scheme assumes these fundamentals and introduces the learner accordingly, while Chem. Study Programme proceeds in its own typical way as is clear in chapter 18.

31. Nomenclature, Methane, Ethane, Homologous series Isomerism, Petroleum

Every subject or discipline has got its own terminology and the same is true of organic chemistry. The words; Nomenclature, homolegous series and isomerism have got their own meaning in Organic chemistry and these among many others constitute the organic terminology.

Methane & Ethane are the first two members of the

hydrocarbon as a homologous series and their methods of preparation, their properties and uses have been discussed in the text in the CBSE scheme. The inclusion of these two members gives a good introduction to the students of the Hydrocarbons in particular and of organic chemistry in general.

Petroleum is a compound of dark, dingy and viscous nature and is composite mixture of various hydrocarbons-both saturated and unsaturated, gaseous, liquids and solids. It occurs under the surface of the earth at varying depths. Its extraction and refining are industrial processes and the petrol obtained runs our vehicles.

This CBSE scheme gives all details regarding the above sub-topics and the Chem. Study Programme deals them in its own way. Homologous series, discussion about Methane & Ethane and that about petroleum are missing from the Chem. Study Programme.

32. Unsaturated hydrocarbons; ethylene & acetylene. Characteristic behaviour of unsaturated molecules

In addition to methane & ethane, which are saturated hydrocarbons, the CBSE scheme envisages the discussion of unsaturated hydrocarbons. The two representative specimens of the two classes of unsaturation selected are ethylene and acetylene. The first gas represents a double linkage and the second gas stands for a triple bond. Thus both of these have significance for the beginner. Again, characteristic properties are attached to such molecules

and the same is studied in details in the CBSE scheme. The Chem. Study on the other hand is excluding all such details. It discusses about unsaturatin but not about ethylene and acetylene.

33. Preparation & properties of CH_3OH, C_2H_6OH, HCHO & CH_3COOH

After the study of hydrocarbons in organic chemistry, we have alcohols, aldehydes, ketones, acids etc. and so on.

CH_3OH & C_2H_6OH are both first two members of alcohols, HCHO is a typical (first) aldehyde and CH_3COOH is first among carboxylic acids. All these compounds, their preparation and properties give a good insight into these respective families and thus students learn a lot about these.

The CBSE scheme includes all these details and the Chem. Study takes up as usual the detailed study of higher concepts. But their individual details, preparation and properties etc. of all these compounds are not given

CHAPTER - 6

CRITICAL SURVEY OF TOPICS [illegible] IN CHEM. STUDY PROGRAMME BUT NOT INCLUDED IN THE CBSE SCHEME, NEW DELHI

Before we take upthe critical survey of those topics, which have been included in the Chem. Study Programme but not included in the syllabus of the CBSE Scheme, New Delhi and hence excluded from the textual discussion therein in the CBSE scheme, it would be appropriate to make a few observations:-

(i) CHEM. STUDY COURSE NOT FOR ALL

Chem. study course is not meant for all schools to adopt it. Only a few selected schools have adopted it. Likewise, it is not meant for all students, only above average students take up the course. The project is still in an experimental stage.

On the other hand, the syllabus framed by the CBSE, New Delhi is meant for all schools falling under the territorial jurisdiction of the Central Board of Secondary Education, New Delhi to adopt it and it is meant for all students, whosoever happens to take up the Higher Secondary examination.

(ii) CHEM. STUDY: A fine human endeavour

The Chem Study Programme is an out come of the efforts of persons as highly placed as Noble-Laureate Prof. G.T. Sea Borg as it chairman and Prof. J.A.Campbell as it Director and the Board of contributors includes about two dozen eminent University Professors College Teacher-Educators and School Teachers in the subject and so on. It is a programme with distinction.

On the otherhand, the CBSE Syllabus is, of course, an outcome of the elite connected with teaching of Chemistry both at the University of Delhi, Delhi and at the Hr. Sec. Schools

in the State, and as such it is better than various other syllabus available elsewhere in the country, yet it is not as a result of specially-felt need as is the case of Chem. Study Course.

(iii) The Student-Associate has an experience (of 6 Years) of teaching Pre-University (& Degree Classes etc.) and hence whatever came by way of criticism or survey for the Text in the CBSE Scheme (as discussed in the previous chapter) is out of that actual teaching experience in the class room situation. But on the other hand, the criticism, regarding the Chem. Study Programme that follows, is as a result of the author's having attended the two Summer Institutes, one in Chemistry (Chem. Study Programme) and other in physics-cum-chemistry (P.S.S.C. Programme & Chem. Study Programme) and having gone through intensively through the Texts (Chem. Study Course), under the guidance and supervision of Dr. K.C. Mathur, Reader in Chemistry, Department of Science Education, while undergoing specialisation in Science Education during the Associateship Course at the National Institute of Education. In other words, criticism to the Chem. Study Programme is not out of direct class-room experiences as the same is in case of the CBSE Scheme.

Having made these observation, we take up for criticism and survey the topics exclusively included in the Chem. Study Programme:-

I. Chemistry: An Experimental Science (CHAPTER - I)

Chemistry is an 'experimental science' is the main theme of the Chem. Study Programme and the programme starts with 'Chemistry': An Experimental Science' as the very first chapter

in the Text meant for the purpose. Here we treat 'Science as a human activity'. Here the approach is not just to relate the activities as such but to give their significance. The reader is made to consider: 'Where do the facts come from ? and what does it mean to explain facts ?'

The answer to these questions really constitutes the gist of the chapter under discussion and the message of the Chem Study Programme as a whole. Though answering these questions seems to be easy, yet it requires introspection, a process not very easy for most of us. The ideas contained in this chapter are probably the most important in the book. The students need a correct view of the underlying pattern of science and of the meaning, limitations and purpose of this pattern. That is why the chapter under discussion is there. The chapter intends to give the students a feeling for the "activities of science" and they (the students) are made to be aware that science, a human activity, is based upon observation; that observation (being carried out by human beings) must necessarily contain uncertainty; that from observation (containing an element of uncertainty) a search is made for regularities, and that from the regularities arises the basic activity of science: 'wondering why ?'

The first chapter thus deals with basic facts of science as a human activity and the very first day the students begin their observation of a burning wax candle. Though the experiment, as it seems to be, is very simple yet it is very much thought provoking and depicts the above 'principles'

in a set sequence. It is not merely seeing a burning candle, but it is all full of scientific activity. The first chapter in the Text and the corresponding very first experiment in Laboratory Manual thus try to ensure that these concepts become part of the students' experience in an orderly sequence . Since the gist of the first chapter is the message of the whole programme, which as a whole is abstract, it has been carefully stated in simple language and couched in familiar metaphor. It has been stripped of the formal trapping that are characteristics of a highly organised system. Thereby the fundamental ideas are placed in sharper focus.

The very first chapter alongwith the corresponding first experiment is the land mark in the whole of the Chem. Study Programme. It begins with Chemistry; an experimental science, and tries to gauge the nature of science by engaging in scientific activity. It picks up the problem which interest a chemist. The chapter is based upon the examples of the activities of the science rather than on definitions.

The programme does away with definitions in a typical American style and at the same time it does not define chemistry, it does not detail, its various branches and so on. It even does not define science, but it enumerates science as as human activity. This is how the Chem. Study PProgramme differs from the CBSE scheme as regards the first and the introductory chapter n the two systems.

As regards the first chapter of text book on

chemistry by an Indian author, the author firstly defines science, enumerates its various branches, defines chemistry and its branches and so on. Here the first chapter never gives a set sequence of 'Principles' to be followed as is the case of the Chem. Study Programme.

A Scientific Model; THE ATOMIC THEORY (CHAPTER -II)

Here in chapter II, the Chem. Study tries to develop the 'atomic theory' on the basis of the 'volume data, which the students collect in the corresponding experiment in the Lab. Manual and thus the theory developed here is not on a historical path, but on students own experiments of collecting volumes etc. Thus the chapter under discussion has two fold purposes:-

(i) to introduce molecules with the help of Avogadro's hypotheses. It tries to show the scientific method in action.

(ii) to show that all gases including O_2 give $PV = constant$. This leads to 'wonder why'. It directly concludes that different gases have different molecules and this differentein molecules in any two gases is due to variation in 'atoms', which subsequently ends by introducing 'symbols' & 'formulaes' etc.

The chapter as a whole revolves around these two ideas and in the light of the said discussion the

following concepts are developed;

(i) the presence of sub-units-atoms-in the molecules of gas.

(ii) Avogadro's Hypothesis

(iii) Relative weight of molecules

(iv) The 'Mole'

(v Models of Molecules

(vi) Symbols and formulaes.

[illegible]

The salient features of the whole discussion, which led to the development of the Atomic Theory in the chapter under discussion, are:

(i) As discussed in the previous chapter, gases are composed of particles. This was applied here in the chapter under discussin to know about the properties of gases i.e. weights of different particles of gases were found to be different ~~as~~ and the difference in gaseous behaviour in terms of colour, solubility in water, behaviour towards litmus all this led to propose that molecules differ in their structure. It was further concluded by saying that molecules contain smaller building blocks called 'atoms'.

(ii) Having presented the existance of 'atoms' we began representing the structure of the molecules through molecular models and molecular formulae. The models and the formulaes picture what is known about the numbers, types and arrangement of atoms in the molecules presented.

(iii. The use of atomic theory and its applicability led to propose that atms are present in solids and liquids. Hence the postulate becomes: Atoms are present in all matter. This is the most imprtant concept developed in the Chapter under review.

(iv) Thus the model (a theory) grows. As it is applicable to various situations, the model of ten grows more complex. The atomic theory, as developed here to co-relate chemical behaviour, is much more complicated than is needed to explain the simple gas behaviour and has led to understand chemistry.

THE CONTRAST

Atomic theory forms an important part of discussion in both the CBSE Scheme and the Chem. Study Programme. But there is a striking difference in the approach between the two projects.

In case of CBSE Scheme, having given a little introduction about gases and about the life of John Dalton, they straight away put forward the Dalton's atomic theory

and then the modern atomic theory. Then such definition as 'atoms, molecules, isotopes and isolars etc. follow.

Next to that it leads us to discuss the Avogadro's Law. But previous to that, we discuss various laws of chemical combination and their derivation etc. in the light of Dalton's theory. All this is traditional and is based upon history of chemistry, as various laws etc. were put up chronologically. The CBSE Scheme follows this approach. Of course, the Dalton's theory and the derivation of the various laws of chemical combination are a land mark of the CBSE scheme - a thing which is nicely missing from the Chem. Study Programme.

But on the other hand, the concept of a scientific model and thereby the growth of the atomic theory without surveying either history or Dalton's atomic theory, the concept of atom, those of molecules and 'moles' follow a natural sequence. This is the strength of the Chem. Study Programme.

The CBSE scheme adopts a historical and traditional approach regarding introducing the learner to atomic theory, while the Chem. Study follows a scientific model and thereby an approach different from historical. In the former, the definitions both precede and follow, in case of the later, the definitions are even omitted.

3. **Chemical Reactions:** (CHAPTER - III)

INTRODUCTION:

Previously in the Cehm. Study, in Chapter I & II,

we have introduced two kinds of changes eg. changes like solidification of wax which are called a phase change and changes like combustion of wax etc. which are called a chemical change or a chemical reaction. Chapter III introduces the learners to the chemical reactions.
CHEMICAL REACTIONS FORM the heart of Chemistry.

The central activity of the chemists is to explore and exploit the later type of changes. Sometimes he causes or brings about a change and sometimes, he tries to prevent it. Always he wishes to understand and control the chemical change. Now to study chemical change in the chapter under review, the effort has been made to see that students develope an understanding of elements and symbols; compounds & formulae; atoms, molecules and moles; and finally chemical change and chemical equation. It is here in this context that the Mole method of solving problems have been vividly introduced and the mole method grows from the balanced equation itself. In other words the language of chemistry is duly stressed and developed herein.

New Concepts developed:

The various new concepts developed herein are;
(i) conservation of Mass (ii) The mole concept & its use in solving problems. (iii) Equation; how it represents a chemical change, its meaning and significance.

The main discussion -The chapter as a whole is devoted to

the study of chemical reaction with the following perspective:

(i) Chemical reactions are introduced via the decomposition and formation of water.

(ii) Conservtion of mass leads to equations

(iii) Calculations based on equations, the mole concept.

The whole discussion is nothing but a real look at some chemical reactions from the students point of view.

7.1. CONTENT

Chemical Reaction forms a backbone in understanding chemistry and chemical reaction is a symbolic representation of a chemical change - this is equally recognised by both the Chem. Study Programme and the CBSE Scheme.

In case of the CBSE scheme, the approach adopted is that there we introduce the learner to chemical reaction directly with the help of chemical equations and thereby we say that as element is represented both qualitatively and quantitatively by 'symbol', a formulae is qualitative and quantitative representative of a compound, the same way the learner is introduced to chemical equation as one which represents a chemical reaction both qualitatively and quantitatively. Of course, intensive chemical calculations are based upon these chemical equations but not via 'Mole concept', as is the theme of such like calculations in the Chem. Study Programme. The CBSE scheme stresses here the balancing of a chemical

equation, the meaning and significance it has got, the information it conveys and finally the limitations of a chemical equation - the concepts - very important from the learners point of view but dealt in the Chem. Study Programme in a different way.

4. Structure of the Atom & the Periodic Table (CHAPTER VI)

INTRODUCTION:

The Chapter under review is an introduction to atomic structure and the periodic table. In other words, the learner is being introduced to the Structure of the atom in the light of the Periodic Law (otherwise much more information regarding the Periodic Table and its treatment in depth follows in Chapters 14, 16, 19, 20, 21 & 22). Here only study of experimental facts and the regularities in them are pointed out. After that have been done, the effort is being made to explain and co-relate them in the light of the structural theory.

Hereafter the effort is being made to show how elements differ in atomic structure as regards their individual atoms. Details of periodic properties by demonstration follows that, which consequently leads to the conclusion that the periodic table is an expressin of 'regularities', the electronic structure of inert gases is used as a basis for organising the regularities that occur in these elements and their behaviour. This is very convincing for students to feel the needs for some sort of classification for a large number of elements and their varied behaviour. The Periodic Table does this for a tremendous number of chemical facts.

The chapter directly exposes students to many new concepts and chemical facts e.g. family relationship, periodicty, group behaviour, regularities in physical properties, or gradation in Chemical Chracteristics - all these follow as a natural sequence to the main discussion: periodic table.

New Concepts:

The Chapter under review tries to introduce the learner to the new concepts as follows:-

1. Discussion of the structure of the nuclear atom.
2. Periodic arrangement of elements emerges as a regularity.
3. Inert gases are chemically distinctive, because they have relatively little chemical activity.
4. Other elements tend to give nearest inert gas configuration and thereby attain inert gas stability.

Outlines:

The Chapter under review has been developed on the following outlines:

1. The introduction to this Chapter serves as an information of a wide variety of Chemical behaviour and properties of the elements.
2. The nuclear atom is discussed as a modle.
3. Atoms are constituted of parts, they have different sizes and weights - all these are discussed.

4. Atomic number is defined as a fundamental property of the element.

5. Isotopes are described, isobars are introduced.

6. Inert gases - as a family of elements - around which the periodic table is developed.

7. Alkali metals, constituting a chemical family next to inert gases follow in the main discussion.

8. Halogens, constituting a chemical family preceding the inert gases, form a part of main discussion.

9. Hydrogen - its dual role and as a family by itself - is discussed.

10. Elements constituting the third row are very prominent and hence they are discussed alongwith.

11. Brief summary of the Periodic table follows last of *all* in the chapter.

THE CONTRAST

The chapter under review gives a picture of the structure of atom vis-a-vis the periodic table. The sequence followed is very logical i.e. first depicting the nuclear structure, then taking up the case of the inert gases and the elements that precede and follow the inert gas behaviour-all this is a natural way of introducing the learner to the periodic law and the periodic classification. Then the concepts of regularities, and allied terminology of the periodic classi-

fication follow as natural sequence. The Chem. Study Programme has done well having introduced all this as such.

On the other hand, the CBSE Scheme introduces the periodic law as above but laying greater stress on the historical perspective of the whole show, a thing which the Chem. Study has done away with.

6. Energy Effects in Chemical Reactions (CHAPTER - VII)

INTRODUCTION:

As pointed out earlier in the previous chapter, a chemical reaction forms the heart of chemistry and in the chemical reaction there is nothing more important than the energy effects that are caused. These energy effects form the core of chemical reactions.

Thus energy changes are an integral part of chemical reactions. This is what the chapter under discussion strives to incorporate. The students are introduced to the idea of energy effects in a chemical reaction by being asked to recollect the warmth the little child in the fable (chapter I) derived from the combustion of wood, to realise the joy an astronaut gets from the reactions of the rocket fuel, to ponder how much heat is evolved when a certain amount of coal burns and how much heat is given out during fomentation, when patient's bottle contains half a litre of boiling water; or how much cooling is caused in one hour in a room fitted with a cooler and so on.

All these examples serve as a good introduction to the energy effects in a chemical reaction. Moreover the experiment No.12 concerned with this serves as a good start to all this.

New Concepts

In the chapter under review, the effort is being made to clarify the following new concepts:-

1. A chemical reaction involve energy.
2. Additivity law of Reaction Heats.
3. Types of energy and the law of conservation of energy.
4. Chemical energy is stored in molecules.
5. Heat content of chemical compounds, heat of reaction, ΔH.
6. Relative magnitudes of energies involved in phase changes and nuclear changes.

Outlines

The following is the main outline of the discussion carried on in the chapter under review:

1. Use of equations forming water gas to stress the difference in reaction heats of different reactins.
2. Heat content, H is defined in terms of the above reaction.

3. 3. The measurement of heat is disclosed in terms of calorimetery.

4. Use of H valves to predict the heat of a reaction .

5. The introduction to conservation of the kinetic energy and the potential energy.

6. Chemical energy is a type of stored energy.

7. Law of conservation of energy

8. Types of energy associated with molecules; kinetic chemical and nuclear energies are discussed

9. Macroscopic effects of a warning are described in terms of the types of energy.

10. Nuclear reaction energy, fission, fusion, mass energy relationship are introduced.

Thus the chapter under discussion tries to bring out in a very simple and lucid style the energy changes associated with a chemical reaction and further tries to introduce the learner with the terminology of heat energy, nuclear fission, nuclear fusion and so on. All this is very interesting from the learner's point of view. The students are thus in a better position to know about nuclear reactions and allied nuclear phenomena and the presentation carried on over here is very logical, systematic and scientific.

The CBSE Scheme, New Delhi, of course, tries to introduce the learner to only heat changes taking place in a simple chemical reaction, otherwise the advance type of discussion

included over here in the Chem. Study course is taken up in Chemistry at the college level in our country.

6. The Rate of Chemical Reactions (CHAPTER - VIII)

INTRODUCTION :

The rate at which Chemical reaction proceeds differs from reaction to reaction. It takes a few months when a wooden piece gets rotten. A piece of iron when exposed to air gets rust in a few days. The digestion of different meals takes a few hours each, the burning of candle is a matter of minutes and the explosion between hydrogen and oxygen (in presence of moisture) by an electric current is complete within seconds. These are all chemical reactions and we have different units of times for expressing all these reactions. The student is being familiarised with different reactions taking different timings to complete. The student is already conversant with the phenomena of chemical reaction; (Chapter II) and the energy effects of chemical reactions (Chapter - 7) . Having learnt that it is essential to introduce the learner to the fact that why some reactions complete spontaneously, and others take months to complete. This difference in timings varies from reaction to reaction and is called the rate of reaction. The concept of rate of reaction is very important from the measurement point of view.

This is what the chapter under review tries to explain.

Not only this, it further envisages the explanation of the same (rate of reaction) in the light of energy effect and the kinetic theory of gases. This is being done with the help of activated complex theory. The theory of activated complex and that of kinetic molecular motion permit an understanding how variation of concentration or of temperature or addition of a catalys can change the reaction rate. The study of rate of reaction is called chemical kinetics and is fundamentals are being made a part of the students knowledge with the help of experiment 14 in the lab. manual. The experiment helps the students to observe directly the effects of temperature and concentration on the rate of a set of chemical reactions.

The chapter poses a challenging situation when the teacher reminds the students that chemical kinetics is one of the frontiers in chemistry and our present knowledge of reaction mechanism is very limited and it is an important and exciting area where a lot off research is to be made. This is so, as specific activated complex is known for only a few reactions and the mechanism is obscure in many other cases.

New Concepts:

Various concepts developed herein in the chapter are as follows:-

(1) The collision theory explains the reaction kinetics in terms of changes in temperature and concentration.

(2) Most reactions proceed on the basis of two

particle collisions. It explains the mechanism of the overall reaction.

(3) Activation energy
(4) Distribution of kinetic energy values
(5) Catalysts influence the rate by providing a new explanation for the reaction.

Outlines:

The chapter under discussion elaborates the subject matter as outlined here:-

(1) General comments about specification of rates
(2) Factors effecting rates of chemical reaction
(3) How the nature of reactions influences the rate.
(4) Collision theory effects concentration and rate of reaction.
(5) Explanation and illustration of reaction mechanism
(6) The collision theory, the temperature effect on reaction rates, distribution of kinetic energy and threshhold energy for reaction are discussed
(7) Activation of energy and the activated complex are introduced. Potential energy diagram explained to describe a reaction.
(8) Heat of reaction is related to potential energy diagram.
(9) The action of catalyst is related to the activated complex and potential energy diagram.

Thus the chapter under discussion tries to introduce

the learners to many sub-concepts as outlined above. These sub-concepts need a thorough understanding before a student is introduced to equilibrium in chemical reactions and various laws governing chemical equilibrium and then to solubility equilibrium (Chapters 9 and 10).

This is a landmark of the Chem. Study Programme to have introduced the above concepts and those which follow it in the next two chapters.

The Indian system of teaching chemistry envisage these concepts to be taught at the college level chemistry course.

7. Equilibrium in Chemical Reactions (CHAPTER - IX)

INTRODUCTION

In the previous chapter, the learner was introduced to the rate of a chemical reaction between carbon monoxide and nitrogen peroxide:-

$$CO\,(g) + NO_2(g) \longrightarrow CO_2(g) + NO(g) \quad \ldots\ldots \quad (1)$$

There we had introduced the learner to the rate of the reaction (1)

Let us now mix carbon dioxide and nitric oxide, we have:

$$CO_2 + NO \rightarrow CO + NO_2 \quad \text{------------} \ldots\ldots \quad (2)$$

Whereby the colour of NO_2 reappears and thus reaction (2) proceeds in a direction undoing the reaction (1). Such a reaction which proceeds in both the direction is called 'reversible reaction'. Here, the colour of nitrogen peroxide firstly disappears showing the progress of reaction (1). But after sometime, the colour changes no more and we may conclude the reaction (2) is undoing reaction (1) such a state of chemical reaction is called 'state of equilibrium'.

Here at this juncture, we raise a number of questions: 'how is that equilibrium reached, is actually equilibrium reached, what are the molecules (both of the reactants and products) doing at this stage, what is the actual composition of the reaction mixture at the point of equilibrium what factors can change the equilibrium conditions and finally to what extent does the reaction proceed in a given direction?

are the various questions which are of wide interest to a Chemist for all chemical reactions.

It is a set of these questions, for which effort has been to give the answers in the chapter under review.

A due emphasis has been laid on the dynamic nature of chemical equilibrium and on its relations to the rate of opposing reactions. All this has been done in the light of Le-Chatelier's Principle, which governs the various changes on the equilibrium of the system.

It once again affords the Teacher with an excellent opportunity to introduce his students to another frontier of chemistry, an area where a lot of research could be carried out. At this juncture the teacher poses the questions; what are the factors which determine equilibrium and why does one reaction favour the formation of products and a similar one the formation of reactants ?

New Concepts:

The chapter under review introduces the new concepts as follows:

(1) Le Chatelier's Principle
(2) Law of chemical equilibrium (Law of Mass Action) expressin for equilibrium constant.
(3) Factors depicting equilibrium conditions.
(4) Equilibrium in a chemical reaction as a dynamic balance of microscopic changes.

Outlines

The following outline of the subject matter has been developed in the chapter under discussion:-

(1) Equilibrium is described as constancy of microscopic pperties in a closed system.

(2) The dynamic nature of chemical equilibrium; microscopic and macroscopic changes in an equilibrium reaction.

(3) The state of equilibrium i.e. relative concentration of reactants and products.

(4) Effects of change of o temperature or concentration on equilibrum conditions.

(5) The rate at which a reaction proceeds or approaches equilibrium.

(6) Le Chatelier's principle; Prediction of changes in equilibrium conditions.

(7) Manufacture of ammonia by Haber's process and governing conditions in the light of Le-chatelier's Principle.

(8) Derivation of equilibrium constant, K.

(9) Significance of the value of K and its use in chemical calculations.

(10) Factors which determine the equilibrium constant.

Thus the Chem. Study Programme introduces the learner to many concepts related to equilibrium in chemical

reactions. From the industry point of view, the chapter as a whole is very significant as the manufacture of so many industrial chemical commodities isgoverned by the laws discussed. herein. It stresses the direct application of chemistry in industry.

On the other hand, theCBSE Scheme does not do so, we take up the same at B.Sc. level.

8. Solubility Equilibria (CHAPTER X)

INTRODUCTION

As discussed in the previous chapter, the principle of equilibrium has a wide applicapability and a greater utility. It is with its help that we understand and control the solubility of the solids (both molecular and ionic solids), and that of gases in liquids. Also solubility of liquids in liquids-called miscibility-presents a different kind of equilibria different from that of solids and gases in liquid and hence discussed elsewhere. But as regards the solubility of ionic solids in water, it poses a very interesting proposition and the chapter under discussion reviews this kind of equilibria.

Solubility is a case of equilibrium is the moot point of discussion in the chapter under review. There are two lines of approach in this chapter. One consists in stressing the individual character of the ions-which means that ions are different from their parent atoms. The distinction between the two is: atoms are neutral particles,

ions are charged particles. Ions are species chemically different from atoms and the difference is that of charge.

Now the other approach makes use of the first; we have ions in a solution and these ions are in equilibrium with each other (equilibrium is between the two oppositely charged ions) and to that of the dissolving media i.e. water (if it is an aqueous sol.). How much of the solute has dissolved how much solvent is required, whether a precipitate will be formed, or it will give a clear solution — all these prepositions are answered by making use of the various laws of equilibrium. This is the second line of action envisaged in the chapter under discussion.

The chapter provides a general survey of ionic reactions and how their behaviour can be predicted. The major goals discussed in the chapter are;

(i) Applying the equilibrium constant to solubility reactions.

(ii) Establishing the concept of ions as separate chemical identies with an independent behaviour.

(iii) Contrasting the solubility of molecular and ionic solids.

(iv) To enable the students to write equilibrium expressions for any reaction and to be in a position to decide whether a precipitate will formed by using a trial ion product.

New Concepts

The new concepts have been developed in the chapter under discussion. These are:

- (i) Ions are distinct chemical species the behaviour of which is distinct from the parent atom.
- (ii) Solubility rules can be used to predict the occurrence of some chemical reactions.
- (iii) Quantitative calculations are based on equilibrium constant.

Outlines

The present chapter introduces the learner to the solubility equilibria, the outline of which are as follows:-

- (i) The dissolving of a molecular solid (Iodine) is used to illustrate the dynamic nature of solubility equilibria.
- (ii) Two oposing rates are discussed.
- (iii) The opeing effects of tendencies towards maximum randomness and minimum energy are used to explain solubility of a solid in different solvents and different gases in water.
- (iv) The formation of electrolytes is related to the periodic table.
- (v) General solubility rules are given for a number of compounds in water and their relationship to periodic table exhibited.
- (vi) Calculations based upon solubility concept and equilibrium constant, Ksp are introduced and discussed.

Conclusion

Thus the chapter under discussion tries to introduce the learner at the school level to various concept underlying the solubility equilibria. All these principles are of industrial importance as it is these principles upon which depends the success of so many industrial chemical preparations. Thus the Chem. Study lays a due stress on the applicapability of physico-chemical processes of industrial importance. On the other hand, the CBSE Scheme does not include these principles, which we in India teach at the college level.

9. Why we believe in ATOMS: (CHAPTER XIV)

INTRODUCTION

The word atom is very common to which a student comes across here and there. For example in chapters 2 and 6, Chem. Study Text, the students are first introduced and then later on more details were given as regards the atom, the charged particles it contains, the nucleus, the electron, the proton, and it was also discussed that the 'atom' is incredibly small and the nucleus, which is its core, is even smaller. The Chem. Study approach is of an enquiry and investigation and its philosphy is that of experimentation. It being so, should we accept the already introduced 'atomic theory' or should the evidence upon which it is based be examined and understood. In other words, should we accept 'Do we believe in atoms?' or verify and examine as to 'why do we believe in atoms?'

The chapter under review is in continuation of the chapter 6 and tries to answer the later question. In other words, it introduces us to 'atmic theory'. It also enumerates the various types of evidence that contribute to our belief in the usefulness and applicapability of the atomic theory. The belief in its usefulness can be drawn from students experiences.

Not only thus, but it also introduces to theory of the theory. The experiments are described, the results are cited and the significance is given - it is the theory of theory or development of the scientific view. In other words, the atomic theory as postulated by John Dalton and the various laws of chemical combination are discussed herein.

New Concepts

(1) Laws of 'Multiple Proportion' and of 'Definite composition' are posed as first evidence for the atomic theory.

(2) Light extends beyond visible spectral range; gamma rays, X-rays, ultra-violet, infrared and microwave frequencies are all part of light spectrum.

(3) Light and its chracteristics; Wave length and frequency.

(4) X-rays reflection and atomic position in the crystal.

(5) Microwave frequency, vibration and absorption of infrared frequencies - all these excite 'rotation',

Outline

The following is the outline of what has been discussed herein:-

(1) 'Garbage collector' analogy and the 'black box' experiment provides introduction to the reasoning: Atomic Theory.

(2) Law of Definite composition, law of multiple proportion and Law of Gaseous volumes - give chemical evidence for 'atoms'.

(3) Faraday's Law; Chemical evidence and quantisation of electric charge.

(4) 'Seeing' parts of the atom.
Mass and charge of the electron; glow discharge tubes and oil drop experiment;
Mass of positive ions; mass spectrograph.
Nuclear atom; Rutherford's scattering experiment.

(5) Dimension of atoms through spectroscopy:
Light, X-ray diffraction from crystals, microwave spectroscopy and infra red spectroscopy.

Conclusion

Thus the chapter under discussion develops 'Atomic Theory' from the vaious laws of chemical combination and the later part gives evidence of the existance of various particles in an atom.

It has been observed that neither the three laws of chemical combination have been stated nor is there any statement of the so called 'Atomic Theory'. Nor is there any derivation of these laws from the theory itself. On the other hand, it has been tried to deduce the Dalton's atomic theory from these three laws. Again, there are five laws of chemical combination, out of which the Chem. Study Text discusses only three. It has omitted the law of conservation of mass and that of 'Reciprocal Proportions'. Though these two laws are as useful as the other three in helping us to understand the Atomic Theory, yet they are missing.

The approach adopted in the CBSE Scheme consists in giving details of the Dalton's Atomic Theory, its various postulates, all the five laws of chemical combination, derivation of these laws from the theory itself and then a set of numerical problems based on these laws. The Chem. Study Text does not take into acount the numerical applicapability of these laws.

Again, Millikan's oil drop experiment, glow discharge tube, mass spectrograph etc. are of huge importance in understanding those concept, yet they are little beyond the level of an XI-form student. Hence the CBSE scheme excludes them concepts.

10. Electrons and the Periodic Table (CHAPTER XV)

INTRODUCTION

Electrons are the fundamental particles present

in any atom. The students so far, by virtue of having gone thrugh the chapters [illegible],6, and 14 have not only come across the terms electron, protn, nucleus, the atom etc., but are very much aware of the fact that the chemical behaviour is related to electrons. In this connectionte the existance and the position alloted to a group of inert gases in the periodic table provide a very important key to the most significant correlation in chemistry i.e. the periodic law. This is so as the position of these elements form the corner-stone of the periodic table and more over their electronic configuration, their stability and the bridge position occupied by these elements - all this helps in the study of the periodic law and in the explanation of the chemical behaviour. For example, the group of inert gases form a key in the periodic table is explained by the electronic behaviour of the alkali metals on the one hand and that of halogens on the other hand.

All the members of the group have zero valency, their electronic configuration is that their outer most is either a complete duplet (in case of Helium) and a complete octet in case of others. Various elements constituting the groups on the right and the left of the zero group try to attain the nearest inert gas configuration by losing or gaining ELECTRONS. This is true of every element. Thus the electrons are basic particles in deciding the chemical behaviour and as the distribution and arrangement of electrons follows a sequence in accordance with the periodic law, hence the study 'Electron sand the Periodic Law' assumes a considerable

significance. Thus the chapter under discussion tries to explore our current understanding of this behaviour. It is the electron population of an inert gas which presents a startling regularity and has led scientists to a detailed and quantitative understanding of the atomic properties and consequently the peridic table.

The detailed discussion in this chapter is centred round the following goals to be achieved here:-

(1) It provides a basis for predicting the chemical behaviour vis-a-vis the periodic table.

(2) It strives to provide the valid picture of electrons and their distribution, as currently accepted.

(3) It strives to provide an explanation of the periodic variation.

Thus finaly, we conclude by saying that the chapter tries to give us an understanding of H-atom, through quantum mechanics, explains the periodic law and correlates the chemical trends in the elements known and still to be know.

New Concepts

The various sub-concepts, which have been introduced in this chapter are:-

(1) Light is a form of energy and it is related to the frequency of light: $E = h\nu$

(2) Atoms can exist in certain 'states' of stationery nature and the excitation by means of energy puts them in higher state.

(3) Motion of electron in an atom is describedby orbitals chracterised by quantum numbers

(4) Electron distribution can extend to infinity, as atoms have no boundry.

(5) Ionisation energy required to remove the most losely bound electron.

(6) Ionisation energy increases as we pass from one element to the other in the same period.

(7) The successive ionisation energies for a single element explain the number of valence electrns.

Outlines

The following is the outline of the detailed discussion incorporated in the chapter under consideration:

(1) Relation between light and energy is established: $E = h.v$.

(2) H - spectrum is used to develop the existence of hydrogen atom energy level diagram.

(3) Bohr's concept of 'stationary states' and quantisation of energies' are introduced to the learner and then a valid view of 'quantum numbers' and orbital' is presented

(4) The energy levels of H-atom provide the explanatin for the first two rows of the periodic table.

(5) Distruction of the Hydrogen atom energy levels reveals the origin of the entire periodic table.

(6) Meaning of ionisation energy and its measurement are introduced.

(7) Chemicaltrends are related to the variation of ionisation energy.

(8) Successive ionisation energies of particles (atoms) are related to the valence electrons.

(9) First long row of the Periodic Table is explained.

Conclusion

Thus we see that the Chem. Study Programme introduces the learner to have a detailed knowledge of the electron vis-a-vis, the periodic table. While doing so, the Text introduces the learner to various concepts e.g. $E = hv$, Hydrogen spectra, energy level diagram, quantisation of energy, concept of orbitals and ionisation energy etc. All these concepts are of wide importance as regards the study of electrons vis-a-vis, the periodic table. That way the Chem. Study Programme tries to introduce these concepts at the school level. On the other hand, the CBSE scheme does not include such discussions as the one

under review i.e. electrons and the periodic table. It simply gives a brief account of the periodic law and the periodic table. These concepts are of minute importance and are introduced at the advanced stage at the college level course.

The framers of the Chem. Study Programme have admitted* that source of these concepts are even beyond the level of Teachers and still all these concepts have been intensively introduced.

11. Molecules in the Gas phase: (CHAPTER XVI)

INTRODUCTION

Though some gases e.g. inert gases are found to be monoatomic, most are not. Gaseous hydrogen is molecular hydrogen i.e. H_2 and not separate atoms of H. Similarly, oxygen, nitrogen, gaseous ammonia, hydrazine, steam, hydrogen perixide, we find in all these compound molecules.

The above discussion raises a number of questions: why are some gases diatomic or multi-atomic ? What holds these clusters together ?

The chapter under review answers all these questions in terms of chemical bonding. The chemical bonding is explained in terms of electrons and simultaneous attraction of the electrons to the two nuclei. The principle applied

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*Background Discussin, Chapter 15 Teacher's Guide

here is the same and is applicable to both ionic and covalent compounds (molecules). The electron orbital filling and tendency towards inert gaseous structure can occur in several ways to give molecules that contain 'satisfied' atoms and hence a 'stable' structure. The valence bond orbitals determine the orbital structure. Since they fix the number of bonds an atom forms and determine the bond angles.

Moreover the chapter under review gives the following for the students to digest them:-

(1) Why molecules are more stable than separated atoms ?

(2) To be in a position to predict as to how many bonds can be formed by an atom specially in case of the elements of the first three rows.

(3) To be in a position to predict the approximate bond angles an atom will form.

(4) To be in a position to predict whether the bond will be a polar or a non polar one

(5) To be in a position to predict about the electric depole in the molecule.

New Concepts

The following are the various concepts developed in this chapter:-

i) Chemical bonding can be explained in terms

of electron - nucleus attraction.

ii) Electron-affinity is explained.

iii) Bonding capacity is related to electron configuration.

iv) Covalent and ionic bonds are treated in terms of ionisation energies.

v) Molecular shape is related to orbital shape.

vi) Molecular dipoles are treated as vector sums of bond dipoles

vii) Electric dipole is related to bond energy

viii) Existence of double bond is revealed.

ix) An idea of triple bond is mentioned.

x) Possibility of cis-trans geomaterical isomerism shown.

Outline:

The following is the outline of the discussion in the chapter under review:-

1. The origin of the stability of a chemical bond is pin pointed. An idea of force of attraction between electron and nucleus is presented.
2. The orbital and electron dot representations of chemical bondings are introduced.
3. The valence orbitals and electron configuration in fixing bondings position of the second-row elements is treated.

(4) Ionisation energies areused to explain and predict ionic character of bonds.

(5) Relation between electric dipole and bond energy is set up.

(6) Bond-angles in the second row flourides are related to available valence orbitals.

(7) Non-zero molecular dipoles is discussedin terms of molecular shape.

(8) Double bonds present in oxygen and ethylene is discussed.

Conclusions:

The chapter under discussion tries to explain atomicity of gases and chemical bondings in terms of valence orbitals etc. It gives an idea of ionisation energies, valence orbitals, dipoles, bond energy, electric dipoles, and finally cis and trans geometerical isomerism.

All the above concepts are very important for understanding the nature of gaseous molecules and the Chem. Study Programme incorporates these as such. But at the same time, these concepts are very hard and not easy to be followed by a student at the higher secondary stage. Hence the CBSE scheme does not incorprate theseas such. We in India, take up these minuter concepts at the college level and even some of these are the topics at the post-graduate level at a university.

Again, though the authors of the Chem. Study

Programme have clearly admitted that those concepts are even beyond the reach of Teachers, yet these have been introduced in the text meant for students. (Background Discussion Chapter 16, T.G.)

12. The Bonding in SOLIDS & LIQUIDS: (CHAPTER XVII)

INTRODUCTION

There is an interaction, between the particles, that holds matter in a condensed phases. The interaction is found to be more intensive in solids, less so in liquids and the least in the gaseous matter. The one between the solids and the liquids forms the main discussion in the chapter under review, and that in gases was discussed in the previous chapter. The main interactions available in liquids and solids are:-

(i) Covalent bonding
(ii) Van derwaal's forces
(iii) Metallic bonding
(iv) Ionic bonding
(v) Hydrogen bonding.

All these interactions are ultimately accounted for by the simultaneous movement of electrons near two or more nuclei. Though this is the common cause, yet these interactions are distinguished because the properties of a system are influenced markedly by three factors:-

(i) Orbital occupancy

(ii) Ionisation

(iii) Charge distribution or (electron sharing)

The chapter under discussion provides a coherent picture of those interactions in terms of these three factors. Before we take up the detailed account of these interactions, it is worthwhile to distinguish between solids and liquids. The distinction is both macroscopic and microscopic. Macroscopically, a soid retains its shape regardless of the shape of the containeer, whereas a liquid tends to assume - at least to the extent its volume allows the shape of the confining vessel. Microscopically speaking, the distinction is two folds. Firstly in solids, the nearst neighbour particles (atoms or molecules) tend to remain in fixed relative positions for a veryy very long period and in liquids, the nearest neighbour particles are constantly changing.

Secondly, the distinction pertains to spatial arrangement or long distance order. Spatial arrangement is not present in liquids and it is present in crystalline solids and in glass (solids) it is absent. The primary purpose of the chapter is to provide the student an understanding of the properties of th various kinds of condensed phases and a basis forpredicting which should be expected for a given chemical substance.

New Concepts

The variousnew concepts developed in the chapter

under consideration are :-

(1) Neutral and non-polar molecules (including inert gas atoms) attract each other weakly. This force of attraction is called van der Waals forces

(2) Covalent bonding accounts for the structure and properties of some solids.

(3) Atoms with low ionisation energy and empty orbitals form metals

(4) Ionic solids are those compounds having very different ionisation energies.

(5) Hydrogen bond is that interaction by virtue of which hydrogen atom bonded to oxygen, nitrogen or flourine can attract or interact with another atom.

Outlines:

The following is the outline of the detailed discussion included in the chapter under review:

(1) Vander Waals forces are discussed with reference to inert gases and of the homonuclear molecules at the right side of the Periodic table.

(2) Covalent bonding is used to explain properties of net work of solids e.g. diamond.

(3) Metallic bonding is treated in terms of vacant valence orbitals and low ionisation energies.

(4) Location of metals in the periodic table and their properties are explained.

(5) Vander waals forces between no-molecular dipole are considered.

(6) Silicates; examples of net work of solids and having covalent bonding are discussed.

(7) Metallic alloys are discussed.

(8) Ionic solids are also discussed.

(9) Interaction between polar molecules and the chemists' interest in bond types are elaborated

(10) Hydrogen bonding is explored. Inter-molecular and intra-molecular H-bonds are discussed.

Conclusion

The chapter under discussion and the one earlie r to that present the heart of chemicalbonding. The material is very important because a good understanding will serve as a strong basis for a grasp of molecular properties. That way the Chem. Study Programme tries to introduce the learner to various concepts as Van der waals forces, Hydrogen bonding, covalent bonding, metallic bonding inter-molecular and intra-molecular Hydrogen bonds – all these are significant and have a meaning for the learner. But what the Chem. Study tries to incorporatein these chapters is somewhat beyond the reach of the common students there in the States too.

The CBSE scheme does not include such details and these are discussed in chemistry course at the college or a university level.

1. Some sixth - and seventh Row elements (CHAPTER-.3)

INTRODUCTION

The Chem. Study Programme deals with the Periodic law in a wide variety of ways. Out of twenty five chapters, eight chapters in the Text under review deal with the Periodic law or periodic classification in one or the other form. Thirty three percent of the textual content in one way or the other is nothing but the study of law of periodicity. Such is its unique importance. In other words in chemistry, one of the most important studies is the study of the Mendeleef's law. It has gone a longway in helping us to study the elements known and still to be known, (Future element 104 and onwards upto 118) - 104, in all as known at present, in the form of eight 'groups' or seven 'periods' only. Elements have been classified into groups and periods. This explains the importance, significance and uniqueness of periodic law.

The various chapters concerning the periodic law are:-

1. Structure of the Atom and the Periodic Law (Chapter 5)
2. Why we Beleve in Atoms (Chapter 14)
3. The Halogens (7th Column of the Periodic Table-(Chapter 19).
4. Electrons and the Periodic Table (Chapter 18)
5. The Third Row of the Periodic Table (Chapter19)
6. The Second Column of the periodic table (chap ter21)
7. The Fourth Row of the Transition elements (Chap ter 22)
8. Some sixth - and seventh Row elements (Chapter 23)

Before we take the actual discussion of the 6th and 7th Row elements, we would like to make a few observations.

In chapters 6, 14 and 15 the general picture of the periodic law has been drawn, the law has been explained and the concerned terminology has been introduced. Meanings of groups periods, gradation in properties etc. has been explained. All this is very important before we take the learner to individual discussions. Chapters 19 and 21 respectively discuss the periodic positions of the 7th column and 2nd column of the periodic table. The seventh column consists of halogens including Astatine (element No.85) - one of the four newly discovered elements. The second column includes the alkaline earths, the last member of which is the first radio-element.

Chapters 10, 22, and 23 respectively take up the periodic positions of the third period, the fourth row including the transition elements (21-30) - the first among the transition series, and 6th and 7th row elements, where we have elements including light and heavy 'rare earths'. The third row starts from element No.11 and ends in No.17 followed by No.18 - Argon, an inert gas. Sodium (No.11) is a leading alkali metal, typical element of the group; alkali metals and is monovalent electro psitive. Chlorine is a leading member of the halogens as a family, typical element of the column, and is a monovalent electronegative.

Argon, No.18 serves as a bridge between sodium, most

electro-positive on the one hand and chlorine-most electro-negative on the other had. It is an inert gas. The third row, consisting of eight elements, includes representative or typical elements and each of these elements represents in properties and behaviour the group to which it belongs. The row itself is a representative period and constitutes the 2nd short period.

The fourth row is the first long period consisting of 18 elements (Nos 19 to 36). The point peculiar regarding this period is that in addition to eight Normal elements, it includes ten elements (Nos 21-30) called the transition elements. As such it is the first period having included a series of ten transitional elements, chracterised by the filling of d-orbitals, having coloured ions, showing variable valencies and exhibiting paramagnetism. All these properties are the characteristics properties of the transitional series. Elements Nos 21-30 constitute first amongst the three transitional series and as such becase of inclusion of this series the row as a whole is the first long period.

Chapter 23-1st chapter in the Chem. Study Programme dealing with periodic classifiction, depicts the 6th and 7th Rows of the periodic table.

The 6th Row onsists of 32 elements numbering from 65 to 86 and as such it is the longest period. The 7th period- the last row consists of 18 elements and the 18th element (Not No.18) of the row is No.104, newly discovered element and as such the period is the incomplete period, the incompletion

being due to non-discovery, so far, of the future elements (104 to 118), of which only 104 has been recently discovered.

The peculiar behaviour, which is common to both these periods -- the longest and the incomplete - is the inclusion of fourteen elements each in the two rows. These two groups of the fourteen elements are included one in each of the two periods. These are called Inner-Transitional series. The first inner transitional series, consisting of elements numbering 58 to 71 is called the anthanides series. The second inner transition group consisting of another series of 14 elements (90-103) is called the Actinides series.

The lanthanides and the actinides are both characterised by the filling of 4-f and 5-f orbitals respectively. The 4f orbital gets completely filled in fourteen elements called lanthanides and the same is true of 5-f orbitals in case of actinides.

These two series - the lanthanides and the Actinides are also called the rare earths, the first series being called the 'light rare earths' and the second is called the 'Heavy rare earths'. The two series - Rare earths - are inner transitional elements this being so, as both of them being transitional series and are preceded and followed by well defined transition elements - hence the name inner transitional elements.

The filling of 'f' orbitals is the common property

of the elements in these two series.

As regards, lanthanides, these 14 elements occur together in a composite ore of lanthanium (element No.57), cluster of ores, containing all these 15 elements and separation is effected accordingly. Coming to Actinides, these are 14 elements, all being radio active by nature, having varying half life period and have been recently synthesised.

New Concepts

Following new concepts have been incorporated here ;

1. Neutron proton ratio and its significance.
2. Nuclear binding energy.

Outlines

The outline of the discussion in the chapter under review is;

1. Lanthanides and Actinides are introduced.
2. Nuclear stability is examined in the light of neutron/proton ratio.
3. Various radio active behaviours are considered. Alpha & Beta decay and electron capture are discussed.
4. Nuclear fusion and Nuclear fission – both are covered.

Conclusions

Having discussed all about the periodic classification in various perspectives in general and about sixth and seventh periods elements in particular, as ____ envisaged

in the chapter under review, we proceed on to conclude the same as follows:-

The Chem. Study Programme gives a vivid and an explicit details of the periodic classification but the periodic law as regards its basic statement, it seems, is found no where in the text. Though one third of the text material as given overhere is pertained to the periodic classification, yet the very statement as to what that law is is absolutely missing. Again, the idea of transition elements as is being tried to be introduced here in chapter 22 is very much beyond the intellectual attainment of an XI - Form student and hence the CBSE Scheme does away with that safely.

We in India, are familiar with the study of elements taken in the form of a group or a column as is being done in chapters 19, and 21. But on the other hand study of elements taken in the form of a horizontal row or a period, say as has been done in chapters 20, 22 and 23 is very uncommon in our system. But the Chem. Study does it all both in the forms of columns and rows.

Again the study of transition elements and for that reason that of Inner Transition elements, as incorporated here in the Chem. Study course, are the subjects we teach at B.Sc. and M.Sc. levels in our Universities. The concepts like transitional behaviours, inner transitional behaviour, 3d orbitals 4f or 5f orbitals, nuclear fission and fusion, neutron proton ratio etc. are the ones discussed in these pages in the Chem.

study course and as pointed out earlier, we teach these concepts at higher level and hence the CBS' scheme does away with all that.

14. Some aspects of Biochemistry; An Application of Chemistry (CHAPTER 24)

INTRODUCTION

A century and half ago, men regarded the chemistry of living organism as something quite distinct from the chemistry of rocks, minerals and other non-living things. It was believed that some mysterious 'vital force' controlled the living organism. With the advent of knowledge, these living organism were synthesised in the laboratory and thus the 'vital force theory' was given a jolt. This resulted in the fusion of the two types of compounds; rocks and fuels on the one hand and living organism e.g. bacteria, fungi, mosses, algea, plants, animals etc. highly organised system of chemical compounds on the other hand. All organism derive the energy for their activities and produce the substances of which they are built by means of chemical reactions.

It is this branch of chemistry, which studies chemical processes in living organism, called Biochemistry. The scientists use information from all branches of chemistry to answer their problems, which mainly are; what kind of molecules make up living system? How does a living system produce the energy it needs ? What structures do biochemicals have ?

The intention of introducing this chapter in the Chem. Study Programme is not to confront the student with many

complex crystals or with multitudes of huge molecules or with that of RNA or DNA but only to introduce to enable him to apply molecular composition, reaction energy effects and molecular structure to living organism or reactions going on therein.

It is with this point of view that Biochemistry is regarded as an aspect of chemistry.

New Concepts

Following may be taken as the new concepts which have been tried to be introduced here:-

1. Chemistry in the body is not different from that in the test tube.
2. Specific arrangement in polymers have an effect on their properties.
3. Cyclic system of reactions are prominent in living system.

Outlines:

The outline of what has been discussed in this chapter is: (1) Sugars - glucose, fructose and sucrose; cellulose and starch, then fats are discussed and their reactions compared to simpler organic compounds.

(ii) The metabolism of glucose is discussed and oxidation cycle of acetic acid given.

(iii) Photosynthesis is discussed briefly.

(iv) Simplified versions of starch, celluse and protein

polymers are given.

(v) A brief treatment of enzymes is given.

Conclusions

Thus the chapter under discussion tries to introduce some common organic molecules e.g. sugars, starch, protein and enzymes etc. It discusses these aspect from the point of view of living organism. It puts the students on a direct conclusion that the reaction going on in our body and the one in a test tube are similar. It means life in a test tube – the theory of RNA and DNA is well introduced. Thus the chapter under discussion is a good trial to apply the chemical aspects to our body system and so on. Chem. Study Programme has done well having given an elaborate discussion of all this But on the other hand the CBSE Scheme does not bother about any such procedure. In some texts on chemistry, a good account of 'Our Food' is given with an elaborate explanation. The Chem. Study Programme has not given any such treatment on 'Our Food' etc.

15. The Chemistry of Earth, The Planets and the Stars (Chapter 26)

INTRODUCTION

So far students have been exposed to a number of experiences and now an effort is being made to clarify his (student's) concept of the universe in terms of his own chemical experiences. The same principle, whether a sample is a test tube full or the entire atmosphere or the universe, holds good. At this stage student's knowledge of reactions in a test tube can be compared to those results of very

slow processes going on in the universe. Planetary chemistry or Geo-chemistry study such changes.

In these days of space-exploration, the chemist is playing a crucial role and the modern age is heavily laden with terrestial problems for the chemist. The elementary knowledge about the earth, the planets and the stars is being given herein this chapter.

New Concepts

1. Three spheres constitute the earth and corresponding to gas, liquid and solid phases as discussed herein the programme.

Use of spectroscopic methods for identifying the chemical constituents of the sun and stars is also discussed (see below)

Outlines:

1. The earth is discussed as one comprising the atmosphere, the hydrosphere and the lithosphere.
2. Practical sources of elements receive some remarks.
3. The age of the earth and ways to determine it are reviewed.
4. Planets are discussed, meteorites, the atmosphere and litrosphere of planets etc. are also discussed.
5. The Sun.
6. Atmospheres around and between the stars is discussed.

Conclusions

The advent of space exploration quickens the pulse of every scientist. As such the chemist role is very significant: preparing rocket fuels, new synthetic elements, new plastics for a new range of performance needs, anticipating environmental chemistry, devising ways to survive in extreme conditions prevailing else where at other planets, collecting and interpreting data about the origin of the earth, the solar system and life itself. It is an exciting age-challenging one, hence we must understand our planet - Earth and the planets surrounding it and stars etc.

That is what the chapter under discussion tries to introduce. The Chem. Study Programme here tries to give the students knowledge about the earth and the surrounding planets. That way it is very good to have introduced our students to the knowledge of earth and the chemical part of it.

The CBSE Scheme does not anyway discuss such concepts though those bits of knowledge are very important from the point of view of the space exploration, yet these are all missing in our school curricula. Hence it is suggested that a due attention be paid to chemistry part of the knowledge about the earth and other planets.

CHAPTER - 7

PRACTICAL WORK IN CHEMISTRY - BOTH IN THE CBSE SCHEME AND THE CHEM. STUDY PROGRAMME- COMPARISON & CONTRAST

INTRODUCTION

Both the Central Board of Secondary Education New Delhi and the Chemical Education Material Study Programme envisage practical work in chemistry as an important part of the study. It has been stressed in both that without practicals the teaching of theoretical chemistry is incomplete. Rather both the CBSE scheme and the Chem. Study Programme lay due stress on the theoratical and practical aspects of chemistry. The importance of practical work in chemistry is clearly laid down in the syllabii of the CBSE Scheme even, where it is clearly mentioned that the students would be required to give an evidence (in their attempts) that they have seen experiment of illustrative and demonstrative nature and further, that they have themselves performed a variety of simple qualitative and quantitative experiments.

Likewise, the importance of the practical work in the Chem. Study Programme is marked by the fact that the Project Chem. Study goes by the name chemistry; 'an experimental science.' The underlying philosophy of the Chem. Study Programme is the emphasis, it lays on the most enjoyable part of chemistry; an experimentation. The above philosophy is further supplemented by treating chemistry as a human (practical) activity, which is the message of the Chem. Study Programme. Not only this, the Programme envisages that chemistry

is a human (practical) activity, it is based upon observation, which in turn must contain uncertainity whereby search is made for regularities, which gives rise to the basic activity of science in general and chemistry in particular that is 'wondering why'. Thus the importance of practical aspect of chemistry is well recognised in both the projects.

The Course-content:

(1) The CBSE Scheme, New Delhi

The content to be covered in chemistry practicals in the CBSE scheme mainly consists of four parts; Part one deals with simple experiments depicting physical and chemical changes and based upon simple chemical operations. The second part covers a wide variety of preparations of various gaseous substances and study of their properties. The next set of experiments deals with simple quantitative excercises in the form of gravemeteric estimations and volumetric titrations. The last and the fourth set consists in carrying on a qualitative analysis of a single soluble salt and finding two radicals, one each from the acid and basic sections.

The total course enjoins about fifty experiments based upon above classification to be performed by the students, undergoing the prescribed course of one year duration under suitable laboratory conditions. In addition to

those individual experiments to be performed by the students, there are some experiments for the purpose of illustration and demonstration by the Teacher.

(ii) The Chem. Study Programme:

Here the total number of experiments to be covered during one year of the Chem. Study Course is 46 including five 'optional' experiments. All these exercises have broadly speaking, been classified into six parts as outlined here:

(1) Part I - Observation and Interpretations, Precision of Measurement (5 Experiments)
(2) Part II - An Introduction to chemistry. The Mole concept. Avogadro's Hypothesis. Gases and Solutions (6 Experiments)
(3) Part III- Investigation of Chemical Reactions illustrating importat Principles (12 experiments)
(4) Part IV - Theoretical concepts. Atomic structure. Chemical Bonds. Structure & Properties (4 experiments)
(5) Part V - Application of Chemical Principles to descriptive chemistry (14 experiments)
(6) Part VI - Optional experiments (5 experiments)

Books on Practical work in the two Projects:

(i) The CBSE Scheme:

As already pointed, the CBSE Scheme, New Delhi is a general scheme covering a set syllabii both in theory and

practical work in chemistry. As such there are various books entitled: 'Book on Practical Chemistry'. To describe one such book, it covers the following: (i) it gives a detailed instruction as to how a beginner is to conduct himself in the laboratory. (ii) It gives a detailed account of how an experiment is to be performed, how the same is to be recorded in the practical note book and it also guides to the extent whether the class experiment is to be signed by the Teacher on the same day or the next day. (iii) It gives a detailed introduction to various sets of experiments, the techniques to be adopted, the apparatus and chemicals to be used and how the same is to be fitted, the theoretical discussion to the experiment and its practical details - all these are described at length in the practical book on chemistry prescribed by the CBSE Scheme. (iv) The book having given all these details gives the method of calculation - both in general for the class of the experiments and in particular for an individual experiment. It also gives an account of 'sources of error' likely to be there in a particular experiment alongwith the precautions etc. to be observed then and therein. (v) Last of all at the end of each chapter, the book on Practical chemistry gives a set of exercised including numerical problems too, to be performed and solved by the students themselves. The exercises chosen are from those set in the Board's examinations during previous years.

The book thus gives various details and runs into about 150 pages.

(ii) Book on the Chem. Study Programme.

The Chem. Study Programme envisages a set of three books and one of them is for chemistry practicals and is called: 'Laboratory Manual'. The three books taken together constitute the "Chem. Study Programme" and hence the Laboratory Manual has got its importance being an indispensible part of the set of books. It is for use by the students. The Teacher can also use it with ease and profit. It gives the various details as follows:

(1) Laboratory Instruction. Laboratory Reports and Laboratory Apparatus

By virtue of that it introduces the student to the laboratory situation and gives the learner a set of general instructions. As regards laboratory reports here it guides how an observation is to be recorded in the laboratory note-book, how various data, calculations, before that procedure etc. are to be taken down in the student note-book. Coming to laboratory apparatus, here a sketch of various set of apparatus to be used and tools etc. required in a laboratory situation - all these are given in the form of sketches etc.

(2) Details concerning individual experiment.

The Laboratory Manual then describes all the forty six experiment, divided into six broad sections and gives the details in each case as explained herein:

(i) It gives a general introduction as to what the experiment is and explains, to some extent, the theory of the experiment.

(ii) Procedure, step-wise and detailed account of various step there in are given for the use by the students.

(iii) Calculations, if any, follow that.

(iv) Last section consists of questions and exercises concerned directly or indirectly with that experiment. It gives a sufficient opportunity to students to prove their knowledge regarding the experiment under discussion.

(3) Appendix:

After the above experiment, follows an appendix, which mainly consists of five optional experiments to be performed by the students and gives various tables of chemical constants and allied details.

The Laboratory Manual is thus a complete guide for the students for succesfully performing the class experiments. The book consists of 138 pages (foolscap paper) and is very useful. The Laboratory Manual is a part of the Chem. Study Programme and the set of three books prepared by a committee of experienced Teachers, Teacher Educators and University Scientists, under the grants from the National Science Foundation.

The Laboratory Manual vis-a-vis the Teacher's Guide

As discussed in Chapter I, the Teacher's Guide is a book on the Chem. Study Programme and it is meant for use by the Teacher alone. It gives a vivid explanation of the various aspects of the Text Bok and the Laboratory Manual. Taking up the Teacher's Guide with respect to the Laboratory Manual, we find that the Teacher's Guide as a complete answer to all the theoretical and experimental details, details of procedure and it gives a thorough solution of all the questions and exercises raised at the end of each experiment in Laboratory Manual. In this connection, the Teacher's Guide gives the following discussion regarding an experiment described in the Laboratory Manual.

(1) Purpose of the experiment. It is important from the Teacher's point of view. The greater need for the students to plan the experiment and the Teacher to administer it has been facilitated by the statement of the purpose of the experiment.

(2) Pre-Lab. Discussion. Here the Teacher introduces his students to experimental and manipulative details.

(3) Equipment Needed. It gives an exhaustive details of all the chemicals and equipments needed in an experiment. This helps the Teacher to see that the things are set in order before the students rush up to the laboratory.

(4) Time required. The usual time alloted for each experiment is 50 minutes and it is indicated there for each experiment

and also break up of this time for various steps in an experiment is also indicated.

(5) Precautions to be observed in each experiment are given in the Teacher's Guide.

(6) Laboratory Hints deal with substitution for apparatus, special problems and points for Teachers background.

(7) Post Lab. Discussion is meant to know whether or not the students have followed the experimental details and to remove their personal difficulties.

(8) 'Answers to Questions' gives complete solutions of all the problems raised at the end of each experiment in the Laboratory Manual.

(9) Suggested Experiment Report Sheet. It means the neat report of the observation part of the experiment by the students. It helps to have an easy discussion and look over their results etc.

(10) 'Questions to wonder about & wondering why' is the ultimate goal of the science in general and chemistry in particular. Here further questions are given which are of help to strengthening this trait in students learning habits.

(11) Extension of the experiment - extra curricular investigation. There are some experiments which need to be performed and repeated outside the laboratory too. It takes to extra curricular experiments suggested in the Teachers Guide. Thus Teacher's Guide to Individual Experiment as discussed above

is an important part of the whole discussion.

REVIEW OF THE EXPERIMENTS WITH REFERENCE TO THE TEXT IN BOTH THE PROJECT.

Now we take up the experiments and practical exercises with reference to the text-material both in the CBSE Scheme, New Delhi and the Chem. Study Programme.

1. The CBSE Scheme; Text material and the Laboratory exercises

Now reviewing the text material as being envisaged in the outline of the syllabii attached herewith and the actual class room teaching practices as going on, on the one hand and the experiments prescribed in the syllabus and the actual exercises as being performed in the laboratory situation on the other hand, we find little correlation between the two aspects; theory and practical ~~fof~~ chemistry.

When in the theory class, we are teaching say Dalton's atomic theory, laws of chemical combination, or Avogadro's hypothesis, etc., in the practical class the students are being asked to perform volumetric exercises or those dealing with preparation. It is very likely that when in theory class we take up the teaching of metals, their extraction, their important compounds, by that time students have already finished their salt analysis etc. These analogies can be multiplied.

Thus we see there is no pssible correlation

between what is being taught in the theory class and that in the laboratory situations. This is so because of the very lengthy syllabii etc., both in the theory and laboratory work and as such we have developed the practice that there is no perfect correlation. But at the same time, it may be noted that it is so in practice, but in actual details, the framers of the syllabii of the CBSE scheme tried to include those topics, for practical work, which have some or the other bearing on the principles of laws etc. discussed in the theory class. Every exercise included for being performed in the laboratory situation has an application of the fact etc. taught in the classroom situation. Whatever right or wrong the system we have developed is due to the practices we have been carrying on. Otherwise, the two aspects; theory and practicals, as envisaged in the CBSE scheme of Chemistry, are highly interlinked. Though this is so yet our practices speak otherwise.

2. The Chem. Study Programme;
The Text material and laboratory manual

Here the Chem. Study Programme approaches Chemistry as an experimental science and the whole set up is laboratory oriented. The Chem. study is the laboratory centered course. As such there is a perfect relationship between what is being envisaged to be performed in the laboratory situation and that in the actual class room teaching. Moreover as spelt out in the actual discussion of, say in

chapter I, in the text book and the corresponding five experiments in the Laboratory Manual - things are interwoven. In fact the student is supposed to have finished the first two experiments before he actually gets to text-book on the third day. The detailed study of this schedule of breaking up the chapter into sections and having corresponding experiments duly discussed within that section and then doing the theory section and the corresponding experiment in the laboratory situation does nothing but speaks of a high correlation between the two aspects; text material and exercises included in the laboratory manual.

Again, the various exercises included in the laboratory manual have been classified into five sections, each of which deals with separate and distinct aspects of chemistry. For example experiments numbering 6 to 11 (Lab. Manual) deal with concepts pertaining to introduction of chemistry, the mole concept, the Avogadro's hypothesis, gases and solutions and the corresponding theoretical details have been discussed in chapters 2 to 5 in the text prescribed for the purpose. Here at the juncture, the Teacher's Guide come to his (The Teacher's) help. The Guide clearly lays down in explicit details the inter-relationship between those experiments and the corresponding theory sections of the text material. It guides the teacher as to the corresponding experiment to be taken as a laboratory exercise with reference to the theoretical section having been taught from the Text.

Merits of the two Projects:

Both the CBSE Scheme and the Chem. Study Programme have got their own virtues. Each of them has got a merit of its own. This is so in terms of individual experiments contained in the two projects. This we discuss as under:-

A - Merit of the CBSE Scheme

The Scheme of the Central Board of Secondary Education, New Delhi prescribes four sets of exercises, as classified in the present chapter. Taking an experiment on individual basis, some of these are found to be very useful and significant. For examples the set of experiments under gravemetoric estimation are the ones of practical importance and these afford the students to learn chemistry on practical basis and find an intensive use in the actual life afterwards. Similarly, the volumeteric exercises included herein have got the above advantages. Moreover the gravemetoric estimations require exact weighing and volumeteric titrations require exact measurement of volume - both these 'exacts' make him (the student) an exact man. While doing these exercises, in addition to being exact, he learns being precise, and clean and maintaining correct and honest (actual) records. The calculation he does here teach him manipulation and explanation of experimental draw backs.

Qualitative exercises have got their own

utility. The students carry on the analysis of a single salt. He learns the systematic procedure of analysing the scheme for both acid and basic radicals. He has to develop patience and learns systematisation, in addition to developing a practical skill. Moreover, it is by virtue of these qualities and by way of knowledge that the student as a chemist in later life uses it in industry. Then there are some preparation of gases and that of two acids. He is supposed to study their properties too. While as a student, he prepares these substances, studies their properties and knows about their practical uses. As these gases and acids are the commodities of industrial importance, it is he, who having learnt the techniques as a student, takes up the responsibility of manning these positions as a chemist in later life.

The first set of exercises involving chemical operations are of immense use to students, as they develope various skills out of that. In brief, the students learn a lot from these set of practical exercises and it is out of this stuff that we are having a class, of people, chemists by designation whose services are being exploited in different sectors of industry and thus chemists are doing an immense service in our national economy and in the development of industry. If there is any lacuna in our industry or any of its aspect, it is due to lack of proper research in that direction or due to non-existence, so far,

of the research and development cell in that industry. A good research in this direction need be oriented.

This is the overall picture of the various set of experimental exercises individually and the chemistry practicals taken as a whole, collectively.

B - Merit of the Chem. Study Scheme

The Chem. Study Programme includes some 46 experiments to the performed during one academic year. Broadly speaking, these exercises have been classified under five sets, each involving different principles. But some of the experiments discussed here in are of wide significance. We take up such cases one after the other.

Experiment I: Scientific Observation and Description

Chemistry is, an experimental science, is the first chapter in the text of the Chem. Study Programme. Here we treat science as a human activity. The Programme as a whole tends to give the feeling for activities of science and the student is made aware that science being a human activity is based upon observations and observation (carried by a human being) must necessarily contain uncertainty, which necessitates search for regularities, which ultimately gives rise to basic activity of science.

This is the gist of the first chapter and the message of the Chem. Study Programme. The corresponding

experiment depicting above challenges is experiment I, Laboratory Manual. Here the students begin to observe a burning candle. Though the experiment, as it seems to be is very simple, yet it is very much thought provoking and depict the above principles in a set sequence. It is not merely seeing a burning candle, but it is full of scientific activity. The first experiment alongwith the first chapter in the text ensure that these concepts become part of the students experience in an orderly sequence.

Thus the experiment I is most striking and significant as a scientific activity. Though it is the easiest possible experiment, yet it forms a class by itself. It is an experiment without experimentation, tools and apparatus. A burning wax candle is all that is needed.

Now proceeding further, experiment 2,3 and 4 are interesting. In experiment 2, the student compares behaviour of common solids on warming - a very interesting though no much of chemistry involved. Experiment 3 is the study of melting temperature of a pure substance - the way it is done is very interesting as it requires to study both warming and cooling behaviour. Experiment 4, combustion of a candle and thereby production of carbon dioxide and water- the test of their formation makes it an interesting situation. Experiment 5 involves use of both a centigram balance and a plateform balance and studies heat of combustion and that of solidification making the whole procedure an

interesting bit. Exercise 6, where weight of equal volume of gases is sought to be found out gives the learner a new and interesting experience. Experiments 7 & 8, taken together give an interesting experience of mass relationship. Experiment 9 & 10 are both, which involve quantitative and qualitative procedure. Experiment 11 introduces the learner about ions in solution. Experiment 12, 13, 14, and 17 study the reaction in its different perspective as regards heat changes and reaction rates. Experiment 15,16, 18 to 21 - all these introduce the students to concepts like solubility products, H-ion concentration, Le-chatelier's principle etc. Experiment 22 is smilar to one (No.11) discussed earlier. Experiment 23 introduces for the first time the learner to volumeteric tetrations.

Experiment 24 is again, the one which is very meaningful to the beginner. Here it involves construction of a logical model by taking different boxes of varying sizes- varying from a match box, cigrette box to one like a shoe box and putting in it an unknown object and expecting the students to know as to the nearest size, shape and nature etc. of the object under consideration. That way it makes a very interesting exercise. Experiment 25 is a quantitative repetition of experiment 7 & 8 and involves the study of electrolysis. Experiment 26 studies geometrical isomerism of cis-trans pairs. Experiment 27 is a very interesting exercise and involves various types of packings, which have a meaning for the young students. Experiment 28 & 29 lin- introduce us to organic reactions. Experiment 30, like

experiment 25 involves the principle of electrolysis. Experiment 31 studies iodine as iodide and iodate ions. Experiment 32 is very interesting as it takes the comparative study of the third row from Na to Cl, the most electropositive and most electro negative extremes of the period under discussion. It gives a practical basis to the study of the periodic table. Experiments 33 to 36 are all based upon qualitative analysis.

Here it is worth noting that in our scheme we straight away introduce our students to the salt analysis involving classification of various cations as basic radicals and anions as acid radicals, tecking to them about various tests involved, group reagents, prelimary and confirmation tests etc. It is here at this stage that we tell our students about six groups of cations and various groups of anions and all that. We first tell our students by 'chalk' and talk' method before he goes to the laboratory. This is the CBSE scheme.

On the other hand, in Chem. Study Programme the approach is entirely different. Here students develope their own scheme of analysis, they are not dictated tests of cations and anions as we do in our system and thus the beginner starts here as an independent research worker. In other words, the Chem. Study scheme proceeds on enquiry and investigatory approach and the CBSE scheme is traditional and consists in facts being related by chalk and talk method.

Comparison and contrast

The two schemes - the CBSE & the Chem. Study have got so many experiment which are common to both and then a set of experiments, which is exclusively discussed in one and not in the other and vice a versa.

A - Experiments common to both the CBSE scheme and the Chem. Study Programme

Following experiments taken individually and collectively are common to both the Projects;

(i) Qualitative analysis of a single salt as included in the CBSE scheme is very muchcommon in procedure and experimental techniques to experiments 11 & 22, 33 to 36 out of which the last four experiments are nothing but developing scheme of qualitative analysis.

(ii) Volumeteric tetrations are an important part of the syllabii in the CBSE scheme and it includes acidimetery and alkalimetery.

The parallel experiments in Chem Study Programme are experiments 9, 10, 18 and in experiment 22- where quantitative titration i.e. titration of an unknown alkali solution is being carried out against standard hydrochloric acid.

The Chem. Study Programme does not stress much regarding qualitative and quantitative exercises, which the CBSE scheme do so at length as explained above.

(iii) Experiments regarding preparations of a double salt, a complex salt, potassium dichromate and chrome alum are very important and have been included in the Chem. Study Programme. These are important because of their preparations involving physico-chemical principles and otherwise im-important from their utility point of view. The corresponding preparations included int the CBSE scheme are those of preparations of various important gases and the hydrochloric and nitric acids. The students learn a lot from those preparation, which, later on, are of industrial importance to him. These two set of exercises are not common but they are not different too.

B - Exercises - exclusively discussed in the CBSE Scheme, New Delhi.

Though there are not very many exercises which have exlusively been discussed in the C.B S.E scheme and which are not included in the Chem. Study Programme, in one form or the other, yet those few which are highly characteristic or peculiar to CBSE scheme are:-

(i) Qualitative analysis forms the main part of the CBSE Scheme and a student is required to do about thirty such exercise, while in Chem. Study Programme includes only four such exercises.

(ii) Volumeteric titrations form an equally important part of our actual laboratory exercises and stu-

dent is required to do about fifteen such exercises, while the Chem. Study Programme includes only one such exercise (Experiment 23)

(iii) Gravemetric estimations as such are the exclusive feature of the CBSE scheme.

(iv) Again the CBSE scheme lay stress on the preparation of simple and common gases and two of three mineral acids, while the Chem. Study Programme only envisages preparation of chrome alum etc. Thus here the CBSE Scheme takes up the preparation of simple gases and common acids, while the Chem. Study Programme takes up those four preparation, which are not very common.

(v) In the very first set of experiments in the CBSE Scheme, simple experiments depicting physical and chemical changes, or those making direct use of chemical operations or those concerned with hard and soft water are taken for being performed in the laboratory situation and an ample practice of this is being imparted, while the Chem. Study Programme does not include these as direct exercises, though these operations are being used here and there in a few experiments.

C – Experiments which are exclusive monopoly of the Chem. Study Programme and not discussed in the CBSE Scheme

There are experiments and experiments which

have been incorporated in the Chem. Study Programme and no mention of the same is given here in the CBSE scheme. We take up such cases as follows;

(i) Experiments 1,2,3,24 & 27 are very much an exclusive feature of the Chem. Study Programme. Experiments 1, 24 & 27 are the land marks of the Chem. Study Programme. These are experiments with a difference and are direct proof of the fact that science is and activity. These are experiments without any much of appratus being involved and experiments without experimentation.

(ii) Experiments: solid copper immersed in silver nitrate solution (7), mass relationship accompany chemical changes (8), reaction of a metal with hydrochloric acid (9); a study of heat of reactions and their rates equilibria (12-15); solubility product (16), reversible reactions (19), oxidation and reduction and their application in cells (20-21); mole-concept (25), cis-tran isomers (26), KI - electrolysis (30), Iodine - its chemistry (31) and comparative study of 3rd Row elements (32), in exchange resins (37) all these are experiments which are an exclusive feature of the Chem. Study Programme and the CBSE scheme does away with them. Then in a set of 'optional'

experiment included herein, the two experiments mass relationship accompanying chemical changes (8a) and study of reaction rates (14a) are also new to the CBSE scheme but have been discussed in the Chem. Study Programme.

Thus, we have outlined the distinct features of the two schemes taken together and also each of those two projects taken separately.

CHAPTER – 6 (a)
(b)

CONCLUSIONS AND SUGGESTIONS

GENERAL INTRODUCTION

It is an age of science and technology. The science is progressing at a rapid rate and that which was discovered a year or so back is now a thing of the past. That way the sputnik or earlier than that the hydrogen bomb and a television – all these are not amongst the recent inventions of science. Dr. [illegible] who performed the first heart transplant operation on Dr. Blaiberg at a hospital in Capetown has passed into history. Out of twenty two heart transplant operations performed till today, about ten persons are doing well. Again, Dr. Arthur Kornberg and Dr. Severo Ochoa who respectively synthesised DNA and RNA and as such set the man on the brink of age of artificial life. As such the molecule of life has been produced in a test tube and new advances in genetics and the creation of individuals etc. – all these experiments are being performed. These are, of course, the recent discoveries of science. Such is the huge importance.

School being an institution of the society and established to realise the set norms and ideals, must reflect the recent and very recent trends in science. Presently teaching of science is in a state of flux and in the light of its huge importance, teaching of science and mathematics has assumed a significant role. If we want to keep pace with the rest of the world, at least with the developing countries, then in that case the teaching of science and mathematics would have to be modernised, old concepts will have to be abolished and replaced by new ones. Hence it is suggested that a model

....contd.

curriculum be adopted for teaching of Chemistry and other school sciences. It is most essential otherwise our very existence would be in danger and we would be left behind in the world's race for happy and prosperous living.

Review of the Existing Syllabus in the CBSE Scheme, New Delhi

As pointed out earlier, the syllabii courses of studies in Chemistry is serving multipurpose ends. But a critical analysis of the same in terms of actual class room practices on the one hand and keeping in view the recent developments on the subject on the other hand, we find the CBSE scheme in Chemistry CONTAINS ~~cannot aims~~ so many topics which need immediate deletion from our syllabii etc. Some of the topics are outdated and they are of no use being retained in any class and some of the topics are such which need be pushed down to lower classes.

The following list gives a detailed account of those topics which are outdated and need not be retained for XI Class (Alongwith each follows the class for which that topic is to be retained):-

(1) Physical and Chemical changes (VIII Class)
(2 Chemical affinity & kinds of chemical action (IX Class)
(2) The atmosphere; Nature of Air (8th class)
(3) Chemical operations; (8th class)
Hard and soft water; (10th class)
(4) Methods of Purification of substances etc. (9th class)
(5) Dalton's Atomic Theory (9th class)
Laws of chemical combination (X class).

Derivation of Laws from the atomic theory (XI Class)

6(8) Gas Laws & Gas Equation (IX Class)

7(9) Molecular weight (X Class)

8(10) Equilant weight (X Class)

9(12) Relation between molecular weight and equilant weight (X Class)

10(15) Structure of flame (IX Class)

11(16) Catalysis (X Class) and their mechanism (XI class)

12(17) Distinction of Metals & Non-Metals (IX Class)

13(19) Hydrogen, Oxygen, water etc. (IX Class)

H_2O_2 and O_3 etc. Redox Reactions (X Class)

14(20) Nitrogen & its oxides etc. (IX Class)

N_2-Cycle and its fixation (X Class)

15(21) Carbon & Carbon Dioxide (IX Class)

16(23 & 24) Sulpher, its allotropy; phosphorous, phosphine (X Class)

16(27) Alloys; individual members (IX class)

Note:

Numbers within brackets above show topic No. in the CBSE Syllabus.

Chemistry Practicals – the CBSE Scheme

Proceeding as above, it is concluded that the following experiments need be deleted immediately and the class for which they need be adopted is given within brackett.

1. Set I – Experiments illustrating physical changes etc. (IX Class)
2. Set II – Preparation of gases (IX Class)

Preparation of Acids.

Hydrochloric acid & ~~sulphuric~~ NITRIC acid (X class)

3. Volumetric Analysis Acid & Alkali Titrations (IX Class)

MODEL SYLLABUS FOR XI CLASS - CHEMISTRY THEORY

INTRODUCTION:

Keeping in view the above recommendations for deleting the said topics in theory and certain experiments in practicals and also having discussed elaborately various aspects of the CBSE Scheme and the Chem. Study Programme, we now suggest the following syllabii to be adopted by the Central Board of Secondary Education, New Delhi.

The CBSE Scheme, New Delhi caters to the need of the Higher Secondary schools within the Union Territory of Delhi. As such the CBSE Scheme has to be a model for other Boards etc. elsewhere in India. Moreover, it is through the existing pattern and syllabii etc. of the Higher Secondary that students prepare for the National Science Talent Search Examination conducted by the Department of Science Education, National Institute of Education, New Delhi-16.

Hence to meet all such challenges and those arising out of explosion of rush for admissions to better science colleges, colleges of engineering & technology and to medical and veterinary colleges, a revised and an upto date syllabii is the first requirement. As such the following syllabii and courses are being suggested for being adopted by the

CBSE for Schools in Delhi and New Delhi.

1. Chemistry: An Experimental Science (Chapter I in toto, Chem. Study Programme).
2. Atomic Theory; some advanced facts. Modern atomic theory, isotopes and isobars. Derivation of Laws of chemical combination from Dalton's atomic theory.
3. Atoms, molecules, chemical symbols and formulae, emperical molecular and structural formulae. valency.
4. The Chemical equation, the meaning it conveys, its significance and limitations. Chemical calculations based upon chemical equations.
5. Historical survey of the periodic classification. Mendeleeff's Law. The periodic table. Modern Law. The anamolies in the Mendeleeff's table and their explanation in terms the modern Law.
6. Structure of the Atom vis-a-vis - the Periodic Table.
7. Electronic Theory of valency vis-a-vis the Zero group of the periodic table. Explanation of chemical Reactions in terms of electronic structure of compounds.
8. The Gas Phase: Kinetic Theory of Gases - Explanation of gas laws in terms of the Kinetic Theory. (Chapter 4, Text Book, Chem. Studies Series).

9. Acids, Bases and Salt (Chapter XI; Text Book, Chem. Studies Series). Some facts regarding classification and nomenclature of these classes of compounds.

10. Electrolysis; Faradays laws and their application explanation of the terms acids, bases and salt.

11. Ionic Theory; Its application to explain; neutralisation, precipitation (solubility product). Electrolysis and hydrolysis.

12. Mechanism of catalysed Reactions.

13. Why we believe in Atoms (Chapter 14, in toto, Text Book, Chem. Studies series).

14. Electrons and the Periodic Table (Chapter 15, in toto, Text Book, Chem. Study Series).

15 (3 & 7) Chemical Reactions & Energy Effects involved therein. (Chapters 3 & 7, in toto, Text Book, Chem. Study Series.)

II – INORGANIC (NON-METALS)

16.   16. Hydrogen and Oxygen; Their commercial preparation. Oxidation – Reduction Reactions (Chapter 12 in toto, Text Bok, Chem. Study Series) Ozone and Hydrogen peroxide.

17. Nitrogen; Nitric Acid – its preparations, manufacture and properties. Ammonia – Its manufacture. Nitrogen cycle. Fixation of nitrogen. Fertilisers.

18. Halogens; Chlorine, Bromine, Iodine their preparation, properties and uses etc. Mention of

Flourine. Hydrahalo acids; Hydrochloric acid, Hydrobromic acid and Hydro-iodic acid- Bleaching Powder, NaOCl.

19. Hydrogen sulphide and Sulpher Dioxide; their preparation, properties and uses. Sulphuric acid. Its manufacture by both the processes. Its chemical reactions.

20. Phosphorous; Its oxides and chlorides, Phosphoric acid.

21. Silica, silicic acid, Sodium Silicate. Glass, Borax and Boric acid.

III - INORGANIC (METALS)

22(a) Sodium. Its extraction by Castner's Process and Down's Process. Its properties and uses. Sodium Hydroxide and Sodium carbonate.

(b) Copper and Silver; their metallurgies, properties and uses. Copper sulphate, silver chloride, silver nitrate. Photography.

23. Zinc and Mercury; their metallurgies, properties and uses. Mercurous chloride, mercuric chloride. (Calomel and Corrosive sublimate).

24. Aluminium; Its ores and extraction from bauxite ores, its properties and uses, Alums, Aluminium sulphate.

25. Lead - its ores and its metallurgy by air reduction process and carbon reduction process. Its properties and use. White lead.

26. Iron; Its occurrence, its metallurgy using Blast Furnace. Steel, its manufacture from cast Iron. Heat treatment of Steel Iron sulphate. Ferric alum. Corrosion of Iron.

IV - ORGANIC CHEMISTRY (Elementary)

27. Distinction between organic and inorganic compounds.

28. Elementary analysis of organic compounds, determination of empirical and molecular formulae from given percentage composition.

29.(a) Hydrocarbons; Nomenclature, Structural formulae, Methane and Ethane, Homologous series, Isomerism, Petroleum.

b. Unsaturated hydrocarbons - Ethylene, acetylene-characteristic behaviour of unsaturated molecules.

30. preparation and properties of Methyl alcohol, ethyl alcohol, formaldehyde, and acetic acid.

MODEL SYLLABUS FOR XI CLASS -CHEMISTRY PRACTICALS

INTRODUCTION

Chemistry is an experimental Science and as such practical work is the essence of any science. Having accepted

Chemistry as an experimental science and having incorporated this essential principle in the form of Chapter I (Model syllabus - Chemistry theory), we now proceed to suggest the model syllabus for Chemistry Practicals.

Set I - Volumeteric Titratins; 16 Experiments.

1. Silver Nitrate Titrations; 6 exercises
2. Acidimetery - Alkalimetery; Advanced titrations including Double titrations and analysis of mixtures of carbonate & Bicarbonate, Sodium hydroxide and Potassium hydroxide etc. etc. (7 excercises).
3. A quantitative investigation of the Reaction of Zinc with sulphuric acid and Magnesium with hydrochloric acid (2 Excercises) (Experiment 9, Lab. Manual, Chem. Study Series.)
4. Reacting Volumes of Two solution - 1 Exercise (Experiment 10, Lab. Manual, Chem. Study Series)
5.

Set II - Gravemeteric Estimations; 7 Experiments

i) Determination of Solubilities and water of crystallisation (one excercise)
ii) Percentage composition of mixtures of two substances one of them being soluble in water or hydrochloric acid (Two excercises)
iii) Behaviour of Solid copper in silver Nitrate solution and Mass relationship accompanying chemical changes (Experiment 7, 8, 9-a., Lab. Manual, Chem. Study Series) (3 excercises).

(iv) Relation between Moles of copper, silver and those of Electrons during Electrolysis (Experiment 26, Lab. Manual, Chem. Study Series) (1 Exercise).

Set III - Qualitative Analysis; 15 Experiments – A single salt soluble either in water or hydrochloric acid and one radical each from;

(i) Basic Radicals; Silver, Mercury (ous); Mercury (ic), Lead, copper, cadmium, Bismuth; Aluminium, Iron, Chrominium, Zinc, Manganese, Nickel, Cobalt; Barium, Calcium, Strontium, Sodium, Potassium, Ammonium and Magnesium

(ii) Acid Radicals, carbonate, bicarbonate, Chloride, Bromide, Iodide, sulphide, sulphite, thiosulphate sulphate, nitrate, Borate and phosphate.

Set IV - Miscellaneous Expriments;

1. Heat of Reaction (Expt 13, Lab. Manual)
2. A study of Reaction Rate (Experiment 14, Lab. Manual).
3. Heat of Acid-Base Reactions (Experiment 17, Lab. Manual).
4. Red-ox Experiment (Experiment 20, Lab. Manual)
5. Electrolysis of Potassium Iodide (Experiment 30, Lab. Manual).
6. Preparation of a double salt and a complex salt (Experiment 39, Lab. Manual).
7. Weight of equal volume of gases (Experiment 6, Lab. Manual).
8. Preparation of Hydrochloric acid and sulphuric acid.

SUMMARY

In the foregoing pages, an effort has been to compare and contrast the content of courses of studies in Chemistry as envisaged both in the Scheme of Central Board of Secondary Education, New Delhi and the Chemical Education Material Study Programme, U.S.A. The comparison and contrast has been discussed in terms of the content courses both in Chemistry theory and practicals in both the systems. For this purpose, the outline of syllabus and one standard book each on theory and practicals as prescribed by the CBSE and then Text Book and the Laboratory Manual - of Chemistry; an experimental science - Chem. Study Programme have been used as reference books - the latter set of books i.e. Chem. Study Series including the Teacher's Guide have been intensively gone through under the guidance of and discussion with Dr. K.C. Mathur and Dr. C. Radhakrishnan, Readers, Department of Science Education and as regards the practicals from the Lab. Manual the same has been done in the Laboratory conditions under the supervision of Shri K.S. Bhandari, Lecturer, Department of Science Education. Dr. M.C. Pant, Head of the Department, Department of Science Education has all along been encouraging me to work hard on the project.

The main gist of the various chapters incorporated here in this Dissertation are;

(1). Chapter I: Chemistry: An elective Science versus Chemistry An experimental Science is introductory and here the two projects, the books etc. prescribed in each of them, the outlin

of the topics which are common to both the CBSE Scheme and the Chem. Study Programme, that of topics exclusively discussed in the CBSE Chemistry and finally the topics which are exclusive monopoly of the Chem. Study Programme, then outline of broad division of experiments into various groups etc. - all these outlines have been given.

It has been clearly brought out that the idea of the Teacher's Guide is new in the educational world and the Teacher's Guide being part of the Chem. Study Programme of teaching-learning process - this is found to be pedagogically sound.

(2). Chapter 2 depicts the 'Philosophy and Objectives' of the two projects. Here it has been stated that Chem. Study Programme envisages Chemistry as an experimental science based upon experimentation on the lines of enquiry and investigation. On the other hand, Chemistry as an elective science and spelt out objectives of the CBSE Scheme have been discussed alongwith.

(3). Chapter 3; 'General Chracteristic Features' in which the broad features and general chracteristics, which are common to both, which are exclusive to one but not in the other project and vice-versa - all these facts have brought out here. For example both the projects - one meant for XI-Form, both are a composite course of theory and practicals etc. etc. - such like things have been discussed over here.

4. 'TEXTUAL COMPARISON' is Chapter 4 where a detailed feature of the topics, units and chapters, which are common to both the CBSE Scheme and the Chem. Study Programme have been reviewed at length. The individual criticism at each point has also been given alongwith.

5. The next Chapter 5 deals with 'Critical Survey of Topics exclusively discussed in the CBSE Scheme, New Delhi and not included in the Chem. Study Programme' and as such it gives distinctive features of Chemistry as it is being taught in India.

6. Critical Survey of Topics exclusively discussed inh the Chem. Study Programme but not included in the CBSE Scheme forms Chapter 6 and as such the distinctive features of as to what Chemistry is exclusively being taught in U.S.A. has been brought out here in this chapter.

7. Having discussed and brought out above facts regarding Text Books etc. and their content in the two Projects, we take up a similar discussion of the content and practices etc. followed in Practical work in the two projects. As such Chapter 7 gives the broad features of the practical work in both the systems.

8. The last chapter is on 'Conclusions, Suggestions and Recommendations' regarding the implementation of the Chem. Study Programme for Higher Secondary (final) class in Higher Secondary Schools in Delhi. The model syllabus both in Chemistry theory and practicals have been suggested.

Supervised by:
Dr. K.C. Mathur, Reader

Submitted by:
A. L. Raina [illegible]

APPENDIX

CENTRAL BOARD OF SECONDARY EDUCATION

NEW DELHI

SYLLABUS AND COURSES OF STUDIES IN

CHEMISTRY (THEORY & PRACTICALS)

XXII - CHEMISTRY FOR GROUP B

CHEMISTRY - THEORY

DISTRIBUTION OF MARKS:

Paper I .... 50 marks

(a) Inorganic - Non-metals ..... 35 marks

(b) Elementary Organic ..... 15 marks

Paper II .... 50 marks

(a) General and Physical ..... 30 marks

(b) Inorganic - metals ..... 20 marks

NOTE: Candidates will be required to give evidence by their answers that they have seen experiments illustrative of all the topics included in the syllabus that they have themselves performed a variety of simple qualitative and quantitative experiments.

SYLLABUS:

TOPICS:

I. General and Physical

1. Chemical change and its characteristics; distinction from physical change; conditions that influence chemical action; chemical affinity; different kinds of chemical action. Ele-

ments, compounds and mechanical mixtures.

2. The atmosphere: The nature and action of air; air a mixture; the part it plays in chemical changes; its relation to plants and animals.

3. Water, hard and soft water: Water as a solvent, solution – saturated and supersaturated, solubility, decantation, filtration, evaporation, distillation and crystallisation. Deliquescence. Efflorescence.

4. Methods for the purification of substances and separation of mixtures. Sublimation.

5. Dalton's atomic theory and laws of chemical combination – law of (1) conservation of mass, (2) definite properties, (3) multiple proportions, (4) equivalent proportions, and (5) gaseous volumes.

6. Atoms, molecules, chemical symbols, valency, and formulae, empirical, molecular and simple structural formulae.

6-A. Atomic constitution of matter: Electronic structure of atom. Electronic conception of valency. Chemical reactions explained on Electronic structure of compounds. Atomic Number. Isotopes.

7. The chemical equation and its significance. Chemical calculation.

8. Three states of matter: Gases, liquids and solids. The general properties of gases, statement and application of

Boyle's law. Charle's law. Dalton's law of partial pressures. Gaseous dissociation. Liquid Gases. Graham's law of Gaseous diffusion.

9. Molecular weight: Definition, application of Avogadro's hypothesis in the determination of molecular weights of volatile substances by Victor Meyer's method.

10. Definition and the simple methods for the determination of equivalent and atomic weights.

11. Acids, Bases and Salts: General methods for their preparation, their general characteristics, classification and nomenclature.

12. Relation between molecular weight, equivalent weight, basicity and acidity. Determination of equivalent weights of acids and bases by volumetric methods.

13. Electrolysis: Faraday's law and application, explanation of the terms acids, bases and salts.

14. Ionic theory: Its application to the explanation of the terms acids, bases, salts; neutralisation, precipitation (solubility product). Electrolysis, Hydrolysis.

15. The structure and nature of the flame. Luminosity of the flames.

16. Catalytic agents, their mode of behaviour, mechanism and application.

17. Characteristics of metals and non-metals. The period-

ic classification of elements.

2. *Inorganic* (Non-metals)

10. (a) Non-metals and their important compounds (including industrial preparation of those given in italics).

19. *Hydrogen*, oxygen; Water, Oxides and hydroxides, Oxidation, Reduction, ozone, hydrogen peroxide.

20. *Nitrogen*, Nitrogen- Oxides, ammonia, Nitric Acid and nitrates, Nitrogen cycle in nature. Fixation of atmospheric Nitrogen and Fertilisers.

21. *Carbon*, carbon dioxide and carbonates. Carbon monoxide. The carbon cycle in nature.

22. *Chlorine*, Hydrochloric acid and chlorides. Bleaching powder. Sodium hypochlorite, Bromine and Iodine (so far as is required to show their relationship to chlorine).

23. *Sulphur*, allotropy, hydrogen sulphide, sulphur dioxide, sulphurous acid and sulphites. Sulphuric acid and sulphates.

24. *Phosphorus*, phosphine, phosphorus pentoxide, phosphoric acids and their sodium salts. The chlorides of phosphorus.

25. *Silica*, actin of silica upon bases, sodium silicate, glass, borax, and boric acid.

3. Inorganic (Metals)

Elementary knowledge of extraction and properties of the following metals (Metallurgical details are not expected) -

26. (i) Sodium, Copper, Silver, Zinc, Mercury, Aluminium, Lead and Iron.

27. (ii) Alloys and their importance, qualitative composition and uses of the following:-

Bronze, Brass, German Silver, Bell-metal, Type-metal, Duralumin and Magnalium.

28. (iii) Study of the following compounds:-

Sodium hydroxide, peroxide, bicarbonate, chloride, sulphate, thiosulphate, nitrate, nitrite and phosphate.

Potassium chloride, chlorate, bromide, iodide, carbonate, nitrate and nitrite.

Silver nitrate, chloride, (photography).

Calcium carbonate, oxide and hydroxide, plaster of paris, carbide, chloride and super-phosphate.

Zinc oxide, carbonate and sulphide.

Mercurous chloride, mercuric oxide and chloride.

Aluminium hydroxide. Alums, oxides of lead, white lead.

Ferrous sulphate, ferric alum. Rusting of Iron.

4. Elementary Organic Chemistry

29. Distinction between organic and inorganic compounds.

30. Elementary analysis of organic compounds, determination of empirical and molecular formulae from given percentage

composition.

31. Hydrocarbons; Nomenclature, Structural formulae, Methane and Ethane, Homologous series, Isomerism. Petroleum.

32. Unsaturated hydrocarbons - Ethylene, acetylene - characteristic behaviour of unsaturated molecules.

33. Prepration and properties of Methyl alcohol, ethyl alcohol, formaldehyde, and acetic acid.

APPENDIX

CENTRAL BOARD OF SECONDARY EDUCATION
NEW DELHI

SYLLABUS & COURSES OF STUDIES
IN
CHEMISTRY (THEORY & PRACTICALS)

XXII – CHEMISTRY FOR GROUP B

CHEMISTRY – PRACTICALS

Chemistry Practical ... ... Total marks ... 50 marks

Set I – A course of experiments to illustrate Physical and Chemical changes, mixtures and compounds, solubility, crystallisation, hard and soft water.

Set II – Preparation and properties of the following:– Hydrogen, Oxygen, Nitrogen, Nitric Oxide, Nitrogen peroxide, Ammonia, Sulphur dioxide, Hydrogen sulphide, Carbon dioxide, Chlorine, Hydrochloric Acid Nitric Acid.

Set III – Gravimetric determination of solubilities and water of crystallisation. Percentage composition of mixtures of two substances, one of them being soluble in water or hydrocholoric acid. Volumetric estimation of common acids and bases involving single titration (Standard solutions to be provided).

Sect IV – Qualitative analysis of single salts (soluble in water and dilute hydrochloric acid) having the following Basic Radcls:–

/-

(Silver, Mercury (ous), Mercury (ic) Copper, Lead Arsenic, Aluminium, Iron (Ferrous and Ferric), Zinc, Manganese, Nickel, Calcium, Barium, Magnesium and Ammonium).

Acid Radicals

Carbonate, Bicarbonate, Chloride, Bromide, Iodine, Sulphite, Sulphide, Thiosulphate, Nitrate, Borate and Phosphate.

TEXT BOOK

CHEMISTRY - AN EXPERIMENTAL SCIENCE
CHEMICAL EDUCATION MATERIAL STUDY

CONTENTS -

CHAPTERS:

1. Chemistry: An Experimental Science
2. A Scientific Model: The Atomic Theory
3. Chemical Reactions
4. The Gas Phase: Kinetic Theory
5. Liquids and Solids: Condensed Phases of Matter
6. Structure of the Atom and the Periodic Table
7. Energy Effects in Chemical Reactions
8. The Rates of Chemical Reactions
9. Equilibrium in Chemical Reactins
10. Solubility Equilibria
11. Aqueous Acids and Bases
12. Oxidation - Reduction Reactions
13. Chemical Calculations
14. Why We Believe in Atoms
15. Electrons and nd the Periodic Table
16. Molecules in the Gas Phase
17. The Bonding in Solids and Liquids
18. The Chemistry of Carbon Compounds
19. The Halogens
20. The Third Row of the Periodic Table
21. The Second Column of the Periodic Table
22. The Fourth-Row Transition Elements
23. Some Sixth-and Seventh-Row Elements
24. Some Aspects of Biochemistry: An Application of Chemistry
25. The Chemistry of Earth, the Planets and the Stars

APPENDIX

1. A Description of a Burning Candle
2. Relative Strengths of Acids in Aqueous Solution
3. Standard Oxidation Potentials for Half-Reactions
4. Names, Formulas and Charges of some Common Ions
Index

LABORATORY MANUAL
FOR
CHEMISTRY: AN EXPERIMENTAL SCIENCE

CHEMISTRY

CONTENTS

Laboratory Instructions

Laboratory Reports

Laboratory Apparatus

Part I – Observation and Interpretation – Precision of Measurement

EXPERIMENT – 1. Scientific Observation and Description

2. Behaviour of Solids on Warming

3. The Melting Temperature of a Pure Substance

4. Combustion of a Candle; A Class Experiment

4-a. Further Investigations of a Burning Candle (Appendix 6)

5. Heat Effects

Part II – An Introduction to Chemistry. The Mole Concept – Avogadro's Hypothesis – Gases – Solutions.

EXPERIMENT – 6. The Weights of Equal Volumes of Gases

7. The Behaviour of Solid Copper Immersed in a Water Solution of the Compound Silver Nitrate.

8. Mass Relationships Accompanying Chemical Changes

8-a. Mass Relationships Accompanying Chemical Changes

8-b. The Formula of a Hydrate (Appendix 6)

9. A Quantitative Investigation of the Reaction of a Metal with Hydrochloric Acid.

10. An Investigation of the Reacting Volumes of Two Solutions of Known Concentration.

11. Reactions Between Ions in Aqueous Solution

Part III–Investigations of Chemical Reactions Illustrating Important Principles.

EXPERIMENT –12. A Study of Reactions

13. The Heat of Reaction

14. A Study of Reaction Rates

14-a. A Study of Reaction Rates I (Appendix 6)

15. Chemical Equilibrium

16. Determinatn of the Solubility Product Constant of Silver Acetate, $AgC_2H_3O_2$

17. The Heat of Some Acid-Base Reactions

18. The Determination of the Hydrogen Ion Concentration of Solutions Using Indicators.

19. Applying Le Chatelier's Principle to Some Reversible Chemical Reactions.

20. An Introduction to Oxidation - Reduction

21. Electrochemical Cells

22. Reactions between Ions in Solution

23. Quantitatic Titration

[illegible] IV - Theoretical Concepts - Atomic Structure - Chemical Bonds - Structure and Properties.

[illegible]PERIMENT - 24. Construction of a Logical Model

25. The Reltion between the Moles of Copper, Moles of Silver and Moles of Electrons Involved during Electrolysis.

26. Investigation of Some of the Properties of a Pair of Cis-Trans Isomers.

27. The Packing of Atoms or Ions in Crystals.

Part V - Application of Chemical Principles to Descriptive Chemistry

EXPERIMENT - 28. Some Reactions of Hydrocarbons and of Alcohols

29. The Preparation of Some Derivatives of Organic Acids.

29-a. The Preparation of Some Polymers (Appendix 6)

30. The Electrolysis of Aqueous Potassium Iodide

31. Some Chemistry of Iodine

32. Some Chemistry of the Third-row Elements Introductory Qualitative Analysis, Experiments